BOTANICAL GAZETTE.

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Botanical Papers before the American Association.

The following is a full list of the botanical papers read befor-Section F at the Ann Arbor meeting of the American Associae tion:

J. C. ARTHUR, Proof that Bacteria are the direct cause of the disease in trees known as pear-blight.

CHARLES R. BARNES, The process of fertilization in Campanula Americana.

CHARLES E. BESSEY, The question of bisexuality in the pond-scums (Zygnemaceæ); also, Further observations on the adventitious inflorescence of Cuscuta glomerata.

T. J. BURRILL, The mechanical injury to trees by cold.

D. H. CAMPBELL, The development of the prothallia of ferns.

JOHN M. COULTER, On the appearance of the relation of ovary and perianth in the development of dicotyledons.

W. G. FARLOW, Notes on some injurious fungi of California.

E. LEWIS STURTEVANT, An observation on the hybridization and cross-fertilization of plants; also, Germination studies.

Mr. Arthur's paper, published in full in this number, excited a good deal of interest, dealing as it did with a subject coming into greater and well-deserved prominence. Prof. Burrill, who had been the first to announce bacteria as the cause of pear-blight, expressed very great satisfaction in Mr. Arthur's results, which proved so directly a view for which he had been for some time contending.

The paper by Professor Barnes, also printed in this number, brought up some recondite facts in the process of fertilization which it would be well for all teachers, at least, to know. The wonderful results of the methods of the German laboratories are in no place better seen than in this whole subject of reproduction. Not the least valuable part of Professor Barnes' paper is his explanation of methods used in obtaining such delicate results.

Professor Bessey, by means of a series of observed forms, showed conclusively that filaments of *Spirogyra* can not be called male or female, as the two functions seem to reside indifferently in the conjugating filaments. The so-called "lateral," or better, "endwise," conjugation, also prevents any thought of a male or female filament. The subject seemed to be of great interest, as touching upon the beginnings of bisexuality. It was suggested by some, in the discussion that followed, that, inasmuch as it is far more common to find in conjugating filaments one entirely empty and the other containing all the zygospores, while the cases observed by Professor Bessey are really exceptional, the plant might be one in which bisexuality is attempted but not yet completely worked out. To others it seemed preferable to consider not the filaments, but the cells as individuals which are perfectly bisexual; while an intermediate view was held, which regarded both the former as right, for *Spirogyra* is a plant which marks not only a first attempt at bisexuality, but in addition to this, bisexuality in groups of individual cells, thus approaching the higher composite individual.

Professor Bessey's second paper was the result of a further study of the adventitious inflorescence of *Cuscuta glomerata*, announced at the Philadelphia meeting. It seems that the flower branch develops from the stem endogenously, while the hold-fasts begin exogenously. These adventitious buds occur only at points of root connection with the host, and a section shows that the plant axis is changing in the direction of the new buds, the old stem presently dying off below. Not only is a new plant axis formed, but for a time at this transition stage the leaf scales contain chlorophyll.

Professor Burrill spoke of two mechanical effects of cold upon trees; the radial splitting of wood and bark, and the separation of bark or wood layers in a concentric way. The first was explained by water freezing in plates parallel to the surface of an organ, and then additions being made to the base, crystals perpendicular to the surface would be formed. Thus the wood contracting, and the ice expanding tangentially and longitudinally (chiefly the former), radial bursting is the result. The south side of a tree is the weakest, as more water exists there, and ice is first formed. Direct observation shows that the specific gravity of sap is greater on the north side of a tree.

Concentric splitting, usually called "wind-shake," was explained by minute ice crystals forming with axis perpendicular to the wood cylinder, thus causing radial tension. Want of ripe-

ness of tissues, in the sense of the relation of water to other constituents, is the chief predisposing cause.

Mr. D. H. Campbell, whose paper appears in this number, in addition to his interesting anatomical study, is to be commended for pointing out the ease with which fern prothallia may be cultivated. These, too often considered material to be obtained with great difficulty, can be cultivated with no trouble. Suggestion was made that such culture afforded a good opportunity for experimenting upon the hybridization of ferns.

Professor Coulter's paper, published in this number, was more in the form of an announcement than a formal paper following completed work. It was readily agreed to by all, in the discussion that followed, that any attempted natural classification of Dicotyledons was better than the artificial one so long in use, and that organogeny might prove as successful in plant classification as embryology among animals.

Following Dr. Farlow's paper, also published in this number, Mr. J. C. Arthur remarked that the hollyhock disease was one of great importance. It was introduced into Europe in 1869, and its progress has been carefully mapped. It has spread rapidly and surely over almost the whole continent. Statements to the effect that this disease had appeared in the United States have been made in various places, but the true hollyhock disease does not exist in this country; the fungus mistaken for it being the same form found by Dr. Farlow, which also occurs in Kansas and New Mexico. The disease is interesting in view of its possible relation to our cotton crop. By Mr. Arthur's suggestion and aid Mr. C. B. Plowright has made various attempts to communicate the disease to cotton plants, but without success. Prof. C. E. Bessey reported the same *Puccinia*, found by Dr. Farlow, on specimens of *Malvastrum* and *Callirrhoe* from Dakota.

Dr. Sturtevant, in his observation on the hybridization and cross-fertilization of plants, used beans and corn as examples, also barley, peppers, squash, etc., and showed that where pure forms are crossed intermediate forms rarely occur. Prof. E. D. Cope, in commenting favorably upon the paper, confirmed the statements, to some extent, from his own experience.

In Dr. Sturtevant's germination studes, Christiana melon seed and Danvers yellow onion were germinated, showing considerable variation in percentage of duplicates; also the germination at low temperature. Prof. Beal spoke of the germination of seeds that had been buried below frost for some time.

It was very evident that botanists were bestirring themselves

to take a more prominent place in Section F. At Buffalo we expect to see still further evidence of this awakening, not only in the number of papers presented, but chiefly in the care shown in their preparation.

The Botanical Club of the A. A. A. S.

The attendance at Ann Arbor was much larger than its most sanguine friends had anticipated, there being eighty-five names entered upon the register. This gave the club twenty-three and one-third per cent. of the total attendance of the association, more than twice as great a proportion as heretofore. Thirty-seven of the members recorded the department of botany in which they are the most interested. These were entered under twenty different headings, but may be reduced to four, as follows: flowering plants and ferns, nineteen; cryptogams, fourteen; physiology, four; and paleophytology, two.

Six sessions were held in all—four in the morning and two in the afternoon—each an hour long, all in the room of the biological section, with the exception of the one on Friday evening, which, by invitation, was changed to Professor Spalding's botanical laboratory. The numbers present at the sessions exceeded seventy-five for several and dropped the lowest at the laboratory gathering, when there were only twenty-eight.

The papers, notes and discussions were of just the kind for which the club was specially founded. Those who heard them can not but have received much valuable information applicable to personal work, as well as having the pleasure of listening to the results of recent studies. The resumé which follows is necessarily very brief, and often omits the items which the listener may have found the most directly serviceable for his own needs.

THURSDAY, August 27, 9 A. M. The chairman made several suggestions of topics for the consideration of the club, which he had already formulated in the last number of the *American Naturalist*: 1. The necessity of uniformity in the use of English names of plant diseases and of the fungi producing them. 2. The advantage of uniform pronunciation of the Latin names of plants. 3. The distribution of botanical literature among the several journals so that each shall represent only certain departments of the science. 4. The relations of the botanists of the country to the National Herbarium at Washington.

In the discussion which followed it was clearly brought out that at present great confusion exists in the use of English names of plant diseases, *e. g.*, the term *blight* is given to the most diverse forms of fungi, as well as to many kinds of disease either partially or wholly killing the plant. To some extent this confusion occurs in most of the English names now in use. It was also shown that the supply of English names was not adequate to the present needs of the subject. Mr. Arthur suggested that it might be possible to prepare a list of English names of fungous parasites and the diseases which they cause, which should be taken as the standard for this country, something in the same way as the American Pomological Society exercises authority over the naming of fruits. After considerable discussion favorable to the suggestion, a committee was appointed to take the matter in charge and report at the meeting next year. The committee are J. C. Arthur, of Geneva, N. Y.; W. G. Farlow, of Cambridge, Mass.; W. Trelease, of St. Louis, Mo., who are to act in conjunction with F. L. Scribner, of Washington, D. C., who is investigating plant diseases for the government.

The second topic was only partially discussed, but the prevalent opinion seemed to be that, although there was much annoyance from the variety of pronunciations, nothing could at present be done to secure uniformity.

The third topic was urged by the chairman, who represents the botanical department of the *American Naturalist*. The representatives of the BOTANICAL GAZETTE preferred to select their material from the whole range of botanical literature. No representatives of the other journals wholly or partially devoted to botany were present, and no result was reached.

The fourth topic was taken up by Mr. Scribner, who spoke of several ways in which the national herbarium might be of direct service to the botanists of the country, and on the other hand of the duty which the botanists owe to the herbarium in the way of contributions of new material. It was brought out in the discussion that few present had any knowledge of the herbarium, or of the facilities for consultation. It was therefore urged that the first requirement was a full statement of the contents and condition of the national herbarium, in order that botanists may know what facilities it offers for present study, and what is desired to make it more complete. The club then appointed J. M. Coulter and W. J. Beal a committee to take the matter under advisement and report at a later session.

THURSDAY, August 27, 5 P. M. Professor Beal gave some

notes on teaching botany. He had found the movement of protoplasm to show well in the hairs on the young buds of many species of plants. The stem of *Smilax rotundifolia* served excellently for histological study. He was of opinion that usually too much time is occupied by lectures, and not enough by laboratory work. He had had students work in various ways, but obtained the best results when considerable time was given to each plant and fewer plants used. Professor Burrill finds difficulty in getting sufficient time for laboratory work. Professor Coulter would have the laboratory open from morning till 4 P. M., and permit students to come and go as convenient to them. Professor Bessey called attention to the scientific course in the University of Nebraska, which is arranged on a plan of alternation. Botany comes but twice a week, which gives plenty of opportunity for laboratory work. The same is true of zoology, physics, chemistry, etc. This arrangement works well when the several professors act harmoniously.

The subject of reagent bottles was then taken up and various devices illustrated and described, followed by a discussion of the several phases and methods of section cutting.

FRIDAY, August 28, 9 A. M. The club received the announcement that two of its former members, Dr. N. L. Britton and Miss Elizabeth G. Knight, both of New York City, had matrimonially united their fortunes on the preceding day, which accounted for their absence from the present meeting. The hearty congratulations of the club were forwarded to them by telegram.

The committee on the relations of the botanists to the national herbarium reported as follows, and its report was adopted by the club:

> It is the desire of the Botanical Club of the American Association for the Advancement of Science to assist in making the national herbarium worthy of its name, that it may offer every facility for consultation and study. They would therefore recommend that as a step in this direction the Department of Agriculture make known to botanists
>
> 1. The contents of the herbarium.
> 2. The number of its types.
> 3. The completeness of its preservation.
> 4. Its convenience for consultation.
>
> Committee { J. M. COULTER. / W. J. BEAL.

Dr. Halsted exhibited specimens of Peronospora and Æcidium from Spirit Lake, Iowa. The former, *P. viticola*, was on wild grapes and so luxuriant as to cover the whole plant with a white velvet and prevented its reaching more than a foot or so in

height. The latter was on Euphorbia, giving the host a peculiar upright growth.

Professor Coulter gave some notes on plants collected by the Greeley expedition to the Arctic regions.

Professor Barnes called attention to the peculiar mode of dehiscence of *Campanula Americana*, by means of a pair of circular trap doors on the sides of the capsule.

Professor Lazenby gave some additions to the published lists of the flowering plants of Ohio.

FRIDAY, August 28, 7 P. M. This meeting was held in the botanical laboratory of the University of Michigan. Professor Spalding first pointed out the facilities of his laboratory. A general discussion ensued on instruments, books of reference, laboratory methods, drawing, courses of study, etc., participated in by Professors Spalding, Bessey, Burrill, Halsted, Campbell, Barnes, Beal and Coulter. This was a specially delightful and profitable meeting to those who were present.

MONDAY, August 31, 9 A. M. The election of officers for the coming year resulted in the selection of J. M. Coulter as chairman and J. C. Arthur as secretary.

The subject of the work at Washington on the diseases of plants was then introduced. The following address was presented, and after some discussion upon the best wording of the last clause, was adopted as the unanimous expression of the club:

To the Honorable Commissioner of Agriculture:

The members of the Botanical Club of the A. A. A. S., recognizing the importance of the movement so happily inaugurated by you, whereby provision has been made for the investigation of plant diseases, would hereby assure you of their hearty support in all your efforts to procure the necessary means for carrying out the work proposed. Inasmuch as researches of this nature will require a considerable expenditure of money, the members of the club hereby pledge themselves to use their influence in inducing their representatives in Congress to make a liberal appropriation therefor in accordance with your estimates.

Mrs. Walcott, of Boston, suggested that a copy of the address be furnished each member of the club, to be presented to his representative in Congress, a suggestion which met with approval.

Professor Burrill spoke of a form of grape rot which had only been recently recognized in this country as a distinct disease, although well known in Europe. It has usually been referred to *Phoma*, but does not have its spores in minute cavities or perithecia as in that genus. It is *Sphaceloma ampelina* DeBy. The spores are unable to germinate on a dry surface, so that shel-

tering the grape clusters prevents its attack. He also exhibited grape leaves bearing *Phoma uvicola*, a mode of occurrence which had been denied.

Mrs. Walcott gave an account of a Campanula, probably *C. Americana*, which made its appearance in some unaccountable way in a row of wild flowers raised from seeds from other localities. These seeds were sown in 1880, and the plants moved to another spot last season. This year there appeared two stalks of the species referred to, apparently, but having some of the flower buds two inches long, the calyx bristly and the flower in eights throughout. She had also observed seedlings of *Yucca filamentosa* near a plant of that species in the garden.

Considerable discussion followed. Mr. Campbell had known of *Yucca* fruiting in Michigan. E. F. Smith recited a case in which weed seeds had appeared to lie dormant for fifteen years or more. It was suggested that in this case there might have been a succession of very depauperate individuals, as some large weeds can fruit and so perpetuate themselves without reaching more than an inch or so in height, and thus escape observation.

Professor Barnes called attention to the erroneous figures of the stomata of Marchantia in all English works on botany. They are shown with six cells in circumference, whereas they have only four. The shapes of the innermost cells, the true guard-cells, and of the outermost cells of the chimney-like stoma are not correctly drawn.

F. L. Scribner exhibited some fine drawings of grasses from which photo-engravings had already been taken, and explained how they were made.

TUESDAY, September 1, 9 A. M. A paper from George U. Hays of St. Johns, N. B., on botanical features of New Brunswick was read, which is published in full in the GAZETTE.

D. H. Campbell gave some hints on growing the spores of *Botrychium ternatum*. The spores are devoid of chlorophyll, both before and after germination, which suggests that they should be grown in rich earth or humus. When prothallia of similar plants have been found they have been below the surface of the ground, and he had devised a plan for sowing the spores under the soil yet so as to be kept under constant observation. The spores of most ferns were germinated in water at ordinary room temperature, and when desiring to carry the growth very far were transferred to some solid substance and kept moist under a bell-jar.

The same speaker had found tabular crystals in the base of

the petioles of *Onoclea Struthiopteris*, which the usual micro-chemical tests proved to be oxalate of lime.

Professor Bessey explained a convenient form of herbarium doors.

J. C. Arthur exhibited specimens of barley, the so-called *Hordeum trifurcatum*, in which the awn of the flowering glume is jointed and bears more or less perfect flowers.

Dr. Walker of New Orleans spoke of the dwarfing of corn grown in a flower pot in his window. Others mentioned similar phenomena.

Mr. Arthur called attention to the erroneous use of the word fungoid by nearly all English speaking botanists. It is properly applied to growths whose origin is not known or which bear some resemblance to a fungus. It can not, however, be properly applied to a fungus or its product. The word almost always intended is either the noun *fungus* or the adjective *fungous*. As a spheroid can not be a sphere, so a fungoid growth can not be a fungus or a fungous growth.

Entertainment of the Botanists at Ann Arbor.

Whatever good feeling and sociability may exist, it can not be disputed that the enjoyment and satisfaction to be derived from large conventions, in which the majority are strangers to each other, are greatly enhanced by social gatherings arranged to bring those of like tastes together. It is on this account that the receptions, excursions, etc., for the Botanical Club may be considered of not much less importance than the other features of the meetings, especially in view of the fact that through contact and personal acquaintance the general elevation of the standard of botanical thought among the members is largely affected.

The only gathering at Ann Arbor specially for the botanists was the excursion by carriage to tamarack swamp. The success of this delightful and thoroughly profitable trip was due to the efforts of Professor Spalding, to whom the club is under many obligations.

As it approached 3 o'clock, Monday afternoon, there was a noticeable exodus from the biological and other sections of the association, and the members of the club and some of their friends were soon seated in the various vehicles waiting outside ready for the start. The excursion was restricted to members of the club, and to such others as provided their own convey-

ances, or for which there was room after the club was seated; yet with these restrictions nearly one hundred participated.

The way lay along a straight, quite level, but pleasant road, for two miles and a half, when the whole company left the vehicles and stepped at once into as fine collecting grounds as the general botanist often sees. We passed first through a thick growth of deciduous trees, then in among the tamaracks. The soil was peaty and damp and the vegetation rank. Nearly all sorts of plants were represented; there were some with showy flowers and more yet of the weedy kinds with inconspicuous flowers that botanists usually prize; ferns, mosses and liverworts made luxuriant growth; the parasitic and microscopic fungi were fairly abundant; the parasitic fungus on scale insects attracted much attention; several interesting species of myxomycetes were found; the pileated fungi, such as toadstools, etc., were specially profuse and of lovely colors and shapes; aerial algæ were taken from the bark of trees, and diatoms and desmids could undoubtedly have been found in the running and standing water had anyone looked for them. In short, there was something to interest the specialist of almost any group of plants, as well as the general botanist. After returning to the carriages another halt was called a half mile beyond and an exploration of a less inviting spot was made, yielding Coptis, Circæa alpina, Drosera, Bartonia, and many parasitic fungi. The party then started on the return by another road, and reached the city in time for tea, having been gone about three hours and half, and traveled seven miles.

This excursion was in every way thoroughly enjoyable and profitable, and one of the most interesting botanical features of the meeting.

The arrangements for registration of the members of the Botanical Club were generously taken in charge by the local committee of the association. They provided the necessary registry blanks, silk badges and attendants. Although greatly indebted for the good intentions of the committee, yet it is to be deplored that the execution was so imperfect that only thirty-seven out of the eighty-five who registered fully complied with the requirements. This was because the blanks and badges were not on hand promptly at the beginning of the meeting. Only half enough blanks were furnished, and the attendants did not give close enough oversight to the registering.

The local committee also promised, as was fully announced, that the botanists would be given an opportunity for collecting on the long excursion of Saturday, whether it went to the Saginaw valley or the Detroit river. When it was learned that no

such arrangements had been made, several botanists gave up the trip entirely and collected in the vicinity of Ann Arbor, while those who did go would gladly have left the boat at any one of several points, had it been possible, and been picked up on the return.

We can only assume that this apparent slight of the botanists was due to a supposition on the part of the local committee that the botanists were an insignificant part of the Association, not meriting much trouble or attention. If this is the proper explanation, the registration of over a fifth of the total attendance as members of the Botanical Club must have brought about a change of opinion before the meeting was over.

Proof that Bacteria are the Direct Cause of the Disease in Trees Known as Pear Blight.[1]

BY J. C. ARTHUR.

It has now been five years since Professor Burrill brought the subject of pear blight before this Association and announced that it was due to bacteria. Previous to that time no instance of bacteria acting the rôle of vegetable parasites had been known, and the discovery was therefore a very important one, opening the way to a new and promising field of research.

The experiments of Professor Burrill showed that the disease alluded to was invariably accompanied by a specific form of bacteria (since named *Micrococcus amylovorus* Burrill), and that as the disease progressed a colorless or yellowish viscid substance was formed, apparently by the action of the bacteria upon the starch and other substances of the plant. The disease results in the complete death of all those parts of the tree that are attacked.

Although from these and subsequent investigations the theory has been quite generally accepted that the bacteria are the cause of the disease, no rigid proof of it has yet been brought forward. It was with a view to either absolutely prove or disprove the theory that a course of experiments was begun last March, and continued to the present time.

It has been incontestibly shown that the disease may be readily transmitted to healthy tissues by introducing a drop of an infusion made by putting some thin slices of the diseased tissues

[1] Read before the American Association for the Advancement of Science, August, 1885.

in water,[2] or by simply transferring a minute portion of the exudation from the diseased to the healthy shoot.[3] The problem was consequently narrowed down to one of two alternatives, either the bacteria were the cause of the disease, or the juices which accompanied them were the cause of it.

The first attempt was to secure some inoculating material in which the bacteria were entirely freed from the juices of the disease. This was done by means of a succession of artificial cultures in a sterilized infusion of corn (maize) meal.

Two series were successfully carried through, extending over about four months, and an inoculation from the sixth culture of each introduced into the green fruit of a Bartlett pear.

The accompanying tables will show the kind of culture vessels used, the amount of culture fluid they contained, and the date at which each one was started. The first culture of the

No. of Culture.	Date of Infection.	Kind of Culture Vessel.	Amount of Fluid.
301	March 27	Salmon culture tube	20 cc.
302	April 1	Salmon culture tube	20 cc.
307	April 21	Sternberg culture flask	½ cc.
309	April 24	Sternberg culture flask	½ cc.
314	May 22	Sternberg culture flask	½ cc.
322	June 5	Test tube with Fol stopper	25 cc.
364	July 13	Bartlett pear on tree	

series was infected with a very small fragment of wood taken from the inner portion of a diseased limb of Flemish Beauty pear, in which the disease had been slowly advancing during the winter, from an inoculation made July 26, 1884, with an infusion of blighted twig from an apple tree. The infection of each of

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309	April 24	Sternberg culture flask	½ cc.
310	April 27	Sternberg culture flask	½ cc.
320	June 5	Test tube with Fol stopper	25 cc.
362	July 13	Bartlett pear on tree	

[2] Arthur, Bull. N. Y. Agric. Exper. Station, xcii: 3d Ann. Rep. N. Y. Agric. Exper. Station, p. 358.

[3] Burrill, Amer. Ass. Adv. Sci., xxix, p. 589; *Amer. Naturalist*, xv. 529. Arthur, l. c.

the other cultures of the series was successively made with a small drop of the one preceding. From the last culture a drop was transferred to a puncture in a ripe Bartlett pear. In both cases the pears were soon filled with the disease. They did not turn brown about the wound, as is the more usual way, but first indicated the presence of the disease by beginning to shrivel, which occurred in one case in nine days after inoculation, and in the other in ten days. Upon cutting the pears open the softer tissues were found broken down and liquefied, and a milky viscid juice ran out, showing that the disease had taken thorough possession.

By this means of fractional culture the juices accompanying the bacteria first introduced were so much diluted in the transfers to succeeding cultures that the final drop used to inoculate the pear was practically free of them, and to the bacteria only, supplied by continued growth and multiplication, can be ascribed the last result.

Having shown that the bacteria when isolated from their juices are able to cause the disease, it still remains to show what action the juices would have when separated from the bacteria. On July 18 a strong infusion of blighted pear was filtered through a porous earthenware vessel, such as used for small electric batteries, and an unripe Bartlett pear inoculated with the filtrate and another pear with the infusion used for filtering. In a week the latter was thoroughly blighted, while the former showed no signs of injury except the slight wound, which finally healed. On July 24 another strong infusion of pear blight was filtered through a second battery cell. Both of these cells were new and had never before been used for any purpose. In this case two unripe Bartlett pears were inoculated with the unfiltered infusion and two others on the same tree with the resulting filtrate. Both the former showed strong evidences of the disease within three days, while the latter soon healed up the small wounds made by the inoculation, and have continued their normal growth.

The evidence is thoroughly satisfactory and conclusive. The bacteria accompanying the disease of trees known as pear blight when fully isolated will produce the disease, while the juices in which they live will not. They are therefore the direct cause of the disease.

Notes on Some Injurious Fungi of California.[1]

BY W. G. FARLOW.

During a recent trip to California I had an opportunity of observing some injurious fungi which attack the native plants, and as they may hereafter be the cause of disease in cultivated plants, it may be well to call the attention of the members of the Association to a few facts with regard to them.

In traveling in Mexico the attention of the botanist is attracted by the pleasing foliage and graceful habit of *Nicotiana glauca* Grah., which is abundant along the railroads and highways, where it often attains a height of ten feet or more. This shrub or small tree is a native of Buenos Ayres, but is thoroughly acclimated in Mexico, and is occasionally cultivated in the greenhouses of our Northern States. Within a few years it has escaped from cultivation in California and is now a common roadside plant from San Diego to Los Angeles and Santa Barbara, and also occurs, but less commonly, still further to the north. While in San Diego I noticed that the leaves of the *Nicotiana* were badly attacked by a fungus which formed large grayish-black spots on both sides of the leaves. The spots were often two inches in diameter, and sometimes even larger, and the circumference was irregular but sharply limited, so that the transition from the healthy to the diseased leaf tissue was sudden.

A microscopical examination shows that the fungus in question is *Peronospora Hyoscyami* De By., which was first found on *Hyoscyamus niger* L., in Europe, where it does not appear to be at all common. Both in Europe and California the spots formed on the leaves are large, and the surface is densely covered with a luxuriant growth of conidia, but, so far as I know, no oospores have yet been found in this species.

Since it is well known that the species of *Peronospora* attack different species of flowering plants which belong, botanically speaking, to the same natural order, it is much to be feared that the disease which now attacks *Nicotiana glauca* may sooner or later extend to the cultivated tobacco, which belongs to the same genus. If this happens, the injury to the tobacco would be very great, since by causing large spots on the leaves to rot they would become worthless for manufacturing purposes. We must at least consider the probabilities with regard to the spreading of the disease. The fungus was only observed by me at San Diego, but it was abundant there. Whether it occurs in Mexico or not I can

[1] Read before the American Association for the Advancement of Science, August, 1885.

not say, but my opportunity for observing in that country was so limited that the fungus might have been very abundant there and still escape my notice. At Santa Barbara, however, I was able to make a pretty careful search, and as far as I could ascertain, the disease has not yet made its appearance there, but from what we know of the history of the spreading of diseases caused by other species of *Peronospora*, there is every reason to suppose that the disease which we are now considering will soon reach Santa Barbara. As tobacco is not an important crop in California, we are less interested in the spreading of the disease in that State than in its extension to the southern states. The *Nicotiana glauca* may perhaps spread northward and eastward until it reaches the gulf states, carrying with it the *Peronospora*, but it is too tender to stand the winters further north without protection. What is also to be feared is that in advancing eastward the fungus may be communicated to some species related to the *Nicotiana glauca*, as for instance *Hyoscyamus niger*, and thus be transported north of the limit where the *Nicotiana glauca* might grow, but where *N. Tabaccum*, the tobacco plant, is cultivated. But this supposition is almost superfluous, because if *Nicotiana glauca* and its parasite are once introduced into the gulf states the parasite might attack the tobacco grown there, and then pass on to Virginia and other states where tobacco is the most important crop.

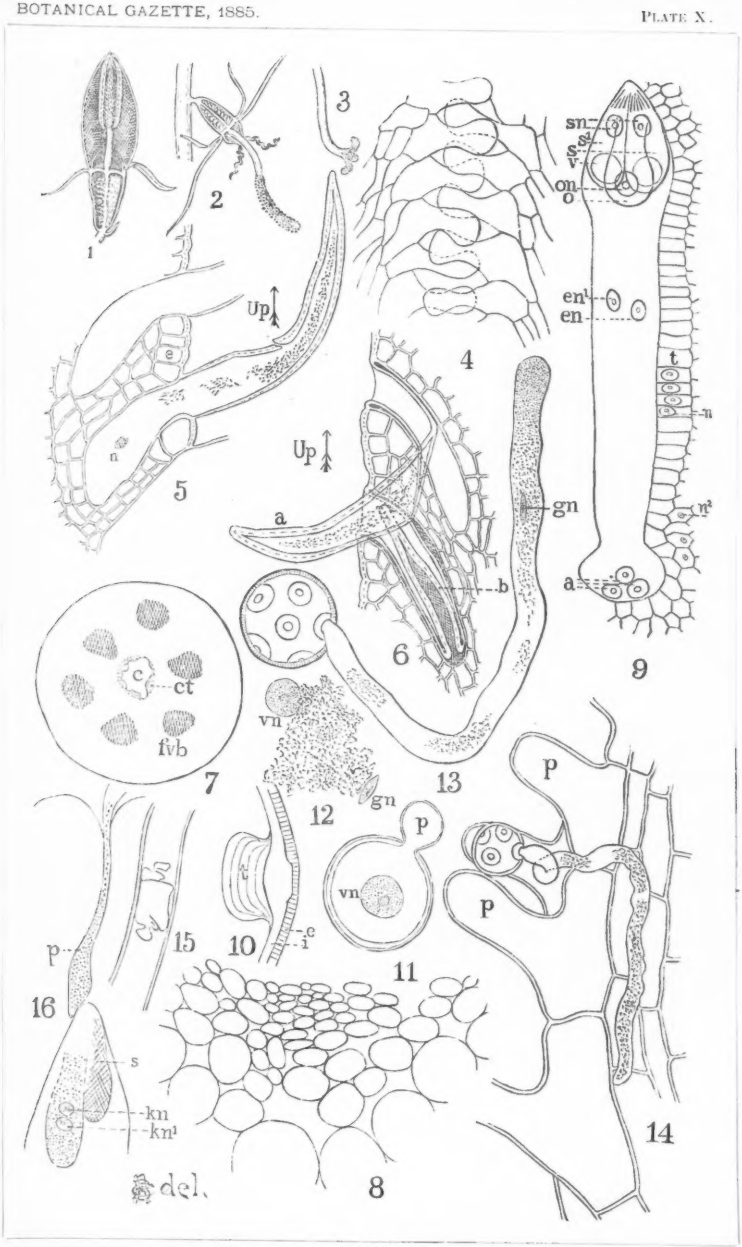
At the Minneapolis meeting I stated in a paper read before the Association that *Peronospora Halstedii*, although one of the commonest species on Compositæ in the eastern and central states, had not yet been found either in the extreme south or on the Pacific coast. I am indebted to Dr. H. W. Harkness for specimens of a *Peronospora* growing on *Madia sativa*, near San Francisco, which is identical with *P. Halstedii*, so that this typically American species extends quite across the continent. *Peronospora leptosperma* of De Bary, known in Europe and the Mississippi valley, I also found to be common at Santa Barbara and Santa Cruz, on *Artemisia Ludoviciana*.

The hollyhock disease, *Puccinia Malvacearum* Mont., which was originally noticed in Chili, has in recent years spread over Europe, and its progress has been more carefully watched by botanists than that of any other plant disease, the potato-rot and grape-mildew perhaps excepted. But while the two diseases last named extended to Europe by way of North America, the hollyhock disease, apparently, was conveyed directly from South America to Europe, and did not pass through the United States.

The only reference[2] to the existence of the hollyhock fungus in this country is in the catalogue of Pacific coast fungi by Harkness and Moore, where it is said to have been found on *Malva*, near San Francisco. A fungus related to the hollyhock fungus has been observed on species of *Malvastrum* in the western states and California. It was first seen by Mr. D. Cleveland, near San Diego, in 1875, and has been seen several times since. By some the fungus on *Malvastrum* has been considered distinct, and even those who have considered it a variety of *P. Malvacearum* have regarded it as distinctly unlike the form found on hollyhocks. When in California I examined with care the different Malvaceæ, to which order the hollyhock belongs, to see whether the true hollyhock fungus did not occur in that state. During a visit to the garden of Mrs. Elwood Cooper, near Santa Barbara, I found the hollyhock covered with a *Puccinia*, and in a canyon near the garden I also found a few leaves of *Malva borealis* L., on which was the same fungus. I at first supposed that what I had found was the hollyhock disease of Europe and South America, but closer examination and a careful comparison with European specimens showed that the form found at Santa Barbara was not the European form, but, on the contrary, precisely the form already known on *Malvastrum* in this country. This is to me rather surprising, for if the fungus on *Malvastrum* is only a variety of the hollyhock fungus, when the disease appears on hollyhocks in this country it should appear in its typical form; and, on the other hand, if the Malvastrum fungus is really a distinct species then the hollyhock disease of Europe is not the hollyhock disease of this country, although both are caused by nearly related *Pucciniæ* of the sub-genus *Leptopuccinia*. A detailed account of the differences recognized in the two forms mentioned is only of interest to mycologists, and a discussion of the subject will come up more appropriately in another connection. In case of the fungus in question, one should consider the possibility that it may attack the cotton plant[3] at some future date, although Cesati states that *Puccinia Malvacearum* has not attacked the cotton in Italy. As far as our own cotton is concerned, danger is rather to be apprehended from *Puccinia heterospora* B. & C., which in its different forms is widely distributed on different Malvaceæ in the southern states.

[2] The mention by Burrill in *Bull. Ill. Lab. Nat. Hist.*, and the several items in the *Gardeners' Monthly*, at different dates, all refer to some other disease.—EDS.

[3] Plowright found by direct experiments that the true *P. Malvacearum* will not grow upon the cotton plant. See *Science*, V. p. 2.—EDS.



BARNES ON CAMPANULA.

The Process of Fertilization in Campanula Americana L.[1]

BY CHARLES R. BARNES.

(WITH PLATE X.)

I have undertaken to investigate some of the more recondite facts in the process of fertilization of *Campanula Americana* in order to increase the number of dicotyledons that have been so studied and to bring to light any peculiar adaptations which might exist.

The investigation of dicotyledonous plants is much more difficult than that of monocotyledons, because the transparence of the ovules and the usually large size of the nuclei which are so common among the latter seldom coexist in any dicot. *Campanula Americana* presents peculiar difficulties in the remarkable opacity of the ovules, though the nuclei are of moderate size.

As preliminary to an account of the study of fertilization, I proceed to give a brief account of the arrangement for cross-pollination which exist in this species.

The plant furnishes a marked example of proterandry, the anthers ripening and discharging their pollen in the unopened bud. The style at this time is not as long as the anthers, and that part in contact with the bursted thecæ is thickly clothed with stiff hairs pointing upward (*fig.* 1). The rapid growth of the style pushes these hairs, like the bristles of a bottle brush, through the thecæ and clears them of all the pollen, which adheres to the style of the now open flower (*fig.* 2). At this time the three lobes of the stigma are not manifest. They do not separate for some time afterward (*fig.* 3). The flowers are visited by wasps and bumblebees, the latter of which in crawling around the almost rotate corolla bring some part of the body, most commonly the hairy thorax or the legs, in contact with the pollen-laden styles of lately-opened flowers or the stigmatic surfaces of older ones. The nectar is secreted in abundance by a series of glands arranged in a circle on the flattened top of the ovary, to reach which the bee has to thrust his tongue between the style and the connivent, broadened bases of the filaments.[2] There is in these plants hardly a possibility of close-fertilization, the pollen being always brushed or blown off the style before the stigmas are at all exposed.

[1] Read before the American Association for the Advancement of Science, August, 1885.
[2] Cf. Gray, Struct. Bot. p. 222, on proterandry of *C. rapunculoides*.

The essential points in regard to fertilization are as follows:

The development of the pollen is quite normal. There appear in each transverse section of the anther from six to eight mother-cells, which have somewhat thickened walls but do not float in liquid. The tapetal cells are unusually large and the three outer rows, particularly the inner, much smaller.

The stigmatic surfaces of the style are covered with nipple-shaped papillæ, the uppermost of which develop sooner than the lower. Those on any lobe interlock with those on the other two and thus prevent the premature separation of the lobes (*fig.* 4). As the growth of the outer surfaces of the style-lobes produces an increasing tension, the lobes finally separate. This separation begins at the base and the tips hold till the stigma is completely mature.

The hairs which brush out the pollen from the anthers (*fig.* 5) have their bases, *b*, deeply sunk in the tissues of the style. They are single-celled. Their tips, *t*, become quite thick and extensively cutinized, and the inner thickening layer is highly refractive. Just at the point of emergence the wall is thinner than at any other place. After these hairs, which are at first rigid, have served their purpose, they become softened and are in some way—I suppose by the contact of insects with the style—telescoped[3], so that the tip is left slightly projecting at the entrance of the pit thus formed (*fig.* 6). The result is as though one grasped the tip of a glove-finger and thrust it in upon itself until only the tip appeared projecting from the hand of the glove. This introversion of the hairs frees the pollen so that it is readily brushed off and carried away. Sometimes a pollen-spore drops into one of the pits and remains as a stopper for it. In the young hairs a beautiful streaming of the protoplasm is easily demonstrated[4].

The style has a small canal in the center, around which the conducting tissue is disposed in a variable number of strands of different sizes (*fig.* 7). Midway between the canal and the periphery are (usually) six fibro-vascular bundles. The conducting tissue, *ct*, is quite small in amount and sharply distinguished from the remaining tissue of the style (*fig.* 8).

The ovules are small, flattened and anatropous, with a *very short* funiculus, so that the micropyle is brought close against the placenta. The embryo-sac is straight and lies in the axis of the ovule (*fig.* 9). It is sharp-pointed at its micropylar end, somewhat larger in its upper fourth than elsewhere, and ends at the

[3] Müller, Fertilization of Flowers, p. 366–7, states that in the genus *Campanula* the hairs shrivel. This is not true for this species, nor *C. rapunculoides*, *fide* Strasburger, Bot. Practicum, p. 103.

[4] Cf. Strasburger's account of similar hairs in *C. rapunculoides*, l. c.

base in a considerable and abrupt enlargement. The tapetal cells, *t*, are unusually large and appear, in longitudinal section, columnar. In each lies a nucleus which is almost as wide as the cell. At both ends of the embryo-sac the tapetal cells become like the other cells of the nucellus. In the basal enlargement of the embryo-sac lie the three antipodal cells, *a*, one of which is usually a short distance above the other two. There are frequently two nuclei, *en*, *en*[1], belonging to the embryo-sac, near its middle. The pointed apex of the sac is occupied by the synergidæ, *s*, *s*[1], which are correspondingly long, nucleated near their upper ends and vacuolated near their lower. A little below the lower ends of the synergidæ lies the oosphere, *o*. It is noticeably more granular than the synergidæ and its nucleus is somewhat larger. A layer of protoplasm lines the embryo-sac and bridles extend in various directions between the egg-apparatus, the nuclei of the embryo-sac and the antipodal cells.

The mature pollen-spore is marked externally with numerous minute elevations (*fig.* 10), hardly more than thickenings of the cuticle, and 3–12 thin spots for the exit of the pollen tubes. At each thin spot in the extine there is a corresponding thickening of the intine.

The mature pollen-spore possesses two nuclei, the larger round one, the vegetative[5] nucleus (*vn*, *fig.* 11), occupying the center of the cell, while the spindle-form, generative nucleus lies to one side. I have been able to demonstrate both of these nuclei in only one case, when, after staining with borax-carmine, I crushed the cells (*fig.* 12). In several cases I have found the vegetative nucleus after treatment with acetic-methyl-green, and in other cases I have seen the generative nucleus in the pollen tubes (*fig.* 13). The difficulty of distinguishing the nuclei in this species is greatly enhanced by the markings on the walls, which simulate a nucleus and nucleolus. Strasburger states[6] that in *C. rotundifolia* the generative nucleus is easily demonstrated after staining with acetic-iodine-green, but it is not so in this species.

I have germinated the pollen-spores in ten per cent. sugar solution, and have obtained tubes of considerable length. In these cultivated tubes I have demonstrated both the vegetative and generative nuclei. The vegetative nucleus is therefore not destroyed in the spore, but passes early into the tube, where it

[5] In this nomenclature I follow Strasburger (*Neue Untersuchungen*, p. 5), which is exactly the reverse of that generally used and even the reverse of that given by Strasburger in *Bot. Practicum*, p. 495.

[6] *Neue Unters.* p. 34.

soon undergoes disorganization. I have seen this nucleus in various stages of destruction. The generative nucleus passes later into tube; indeed it is usually among the last of the contents to leave the spore. I am not able to say whether or not it divides; presumably it does,[7] though I have seen but one such nucleus.

When the pollen tubes are emitted on the stigma they sometimes pass straight and sometimes after turning upon themselves downwards *between*, and not *into*, the bases of the papillæ (*fig.* 14). The conducting tissue runs close beneath the stigmatic surfaces. In this tissue I have traced the tubes for several millimeters. The pollen tubes penetrate the strands of conducting tissue and do not enter the canal of the style. A short distance behind the apex of the tubes cellulose plugs are successively formed (*fig.* 15). These plugs, which have sometimes considerable length, are very prominent objects in longitudinal sections of the style or when the conducting tissue is teased with needles. The latter method permits one to trace the tubes for long distances. The pollen tubes pass down the style and follow the placentæ. When they emerge from a placenta they either enter the nearest micropyle at once or pass further, adhering *very closely* to the surface of the placenta.

I have detected the pollen tubes in a number of micropyles. The difficulty of tracing their further course is greatly enhanced by the opacity of the ovules and the consequent necessity of adopting the section method, as hereafter explained. I have been fortunate enough to find one specimen in which the pollen tube had entered the micropyle and penetrated to the synergidæ (*fig.* 16). In this specimen fertilization had taken place. One of the synergidæ at least (I could not see the other) had become disorganized and there were two nuclei in the oosphere. I am not certain that these were the male and female pronuclei, though they may have been. I am rather inclined to think from the considerable elongation of the oosphere that the embryonal nucleus had just divided preparatory to the formation of the first two cells of the suspensor. After fertilization the embryo-sac enlarges greatly, particularly in its middle third, and the formation of endosperm proceeds at once and rapidly.

The main points established regarding the fertilization of *Campanula Americana* are these:

The tapetal cells of the anther and ovule are unusually large.

[7] Strasburger, l. c., p. 15, states that such division is the rule. I have not yet assured myself that it takes place in this species.

The pollen-spore possesses two nuclei, one of which, the smaller, persists and either with or without division copulates with the female pronucleus.

The pollen tube penetrates between the cells of the stigma and passes down the conducting tissue and not in the canal of the style.

There is the usual generative and vegetative apparatus in the embryo-sac.

METHODS.—For the study of the development of the pollen-spores I used alcohol-fixed buds, which had been twenty-four hours in alcohol-glycerine[8], commencing with those 2mm. in length. The sections of the entire bud were stained with methyl-blue.[9] The plant is an admirable one for the use of students in this respect.

For the study of the pollen-spores themselves fresh material is requisite. The best results were obtained by staining with borax-carmine.[10] The spores are placed in a drop of 2 per cent. acetic acid and after a few minutes a drop of borax-carmine added. This is allowed to remain an hour, the slide being protected from evaporation meanwhile. The stain is then washed out with acidulated alcohol[11] and a drop of dilute glycerine placed on the specimens.[12] The demonstration of the nuclei is extremely difficult.

The spores were germinated in a hanging drop of 3-12 per cent. sugar solution in the usual moist chamber. After three hours they were examined, the cover-glass with the drop being lifted off and allowed to fall on (1) a drop of acetic-iodine-green[13] or (2) a drop of picro-carmine.[14] After a few minutes dilute glycerine is run under the cover. Both yield excellent results. The nuclei in the tubes are thus more deeply stained than the cytoplasm.

Longitudinal sections of the stigmas serve for the study of the entrance of the pollen tubes. I used alcoholic material, without any staining, mounted in glycerine.

The pollen tubes in the conducting tissue may be studied either in longitudinal sections of the style or by laying open the style and drawing a needle through the canal, thus dragging out the conducting tissue. In the latter case care must be taken to

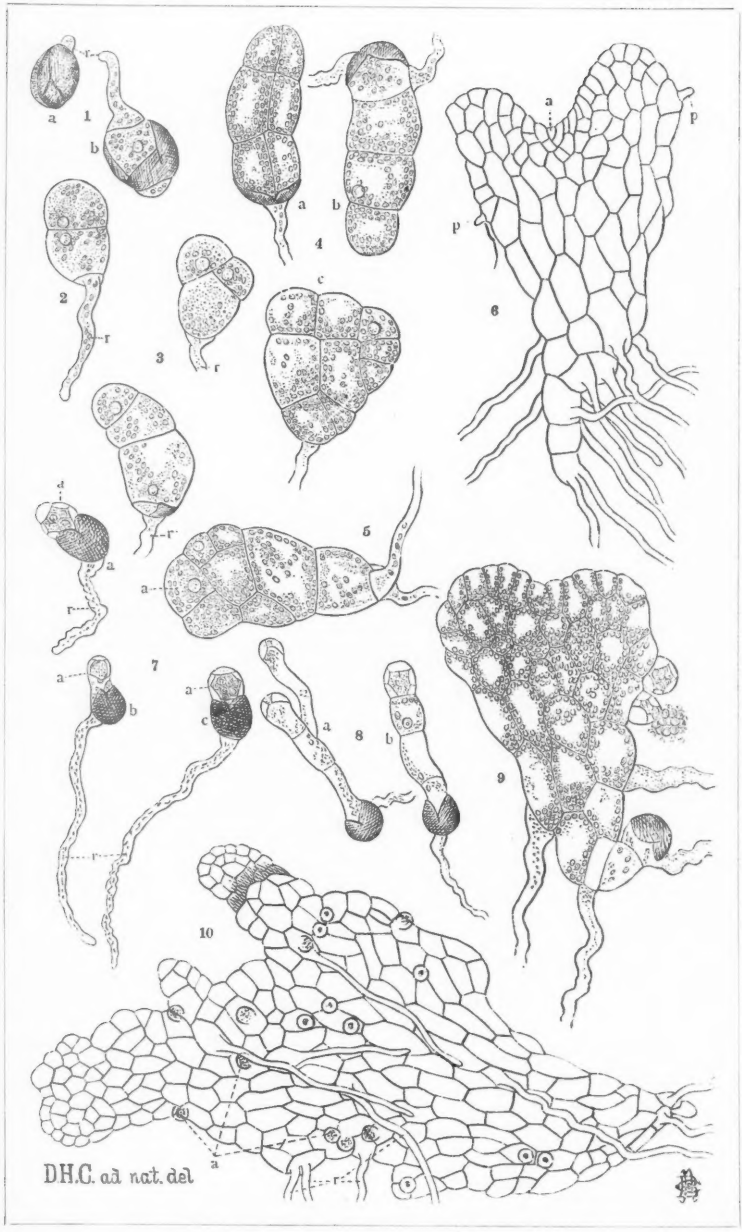
[8] Equal parts of 95 per cent. alcohol and glycerine.
[9] Aqueous solution.
[10] Grenacher's. See Bot. Pract., p. 630, or Archiv. f. mikr. Anat. xvi, 466.
[11] 70 per cent. alcohol. 100cc. HCl, 5cc.
[12] Strasburger, Neue Untersuchungen, p. 7.
[13] A drop of 1 per cent. acetic acid to which a small drop of iodine-green is added Strasburger, l. c., p. 6.
[14] Bot. Pract., p. 630.

tangle the strands as little as possible and methyl-blue should be used as a stain, otherwise the transparency of the pollen tubes renders them very difficult to follow. The very greatly elongated cells of the conducting tissue are almost exactly the diameter of the pollen tubes and are liable to mislead, were it not for the abundant cellulose plugs which occur only in the tubes.

In the study of the ovules material fixed in strong alcohol, in picric acid[15] and in chrom-acetic acid[16] was used. The contraction of the contents of the embryo-sac is unavoidable. I think the alcoholic material is quite equal to the others and less troublesome. I found it necessary to depend on getting chance sections of the ovules by cutting the whole ovary longitudinally and laying the sections in glycerine. Previous to the cutting the material is placed in alcohol-glycerine for twenty-four hours or more. After being mounted in glycerine the sections become clearer and clearer. I also tried cutting sections in various known directions by imbedding the ovules in colored pith to render them more easily seen. The results, on the whole, are not better than by depending on chance sections, and they are much more troublesome.

[15] Saturated aqueous solution.
[16] Chromic acid, 0.7; acetic acid, 0.3; distilled water, 99. Strasburger, l. c., p. 328.

EXPLANATION OF PLATE X.—Fig. 1, A bud bisected in the plane of the axis and bract. × 2. Fig. 2, diagram, an open flower bisected in the same plane; the stigmas unopened and the style laden with pollen. Fig. 3, a style with stigmas open. Fig. 4, interlocking papillæ of stigmas. × 195. Fig. 5, section of style from bud, showing hair; near *n* the remains of the nucleus. × 195. Fig. 6, section of style from which the pollen has been removed; *a*, a hair partly turned out of place; *b*, a hair in normal position. × 195. Fig. 7, transverse section of style; *c* lies in the canal; *ct* (shaded) the conducting tissue; *frb*, fibro-vascular bundle. × 37. Fig. 8, transverse section conducting tissue. × 356. Fig. 9, diagram of embryo-sac; *a*, antipodal cells; *en*, *en*^{1}, nuclei of embryo sac; *n*^{1}, nucleus of tapetal cell; *n*^{2}, nucleus of a parenchyma cell of the nucellus; *o*, oosphere; *on*, nucleus of oosphere; *s*, *s*^{1}, synergidæ; *sn*, nucleus of synergida *s*; *t*, tapetal cells; *v*, vacuole of synergida *s*^{1}. Fig. 10, diagram, optical section of wall of pollen-spore through one of the exit spots; *e*, extine; *i*, intine; *l*, stratified local thickening of intine. Fig. 11, a pollen spore, showing vegetative nucleus, *vn*; *p*, a beginning pollen tube. × 356. Fig. 12, part of the contents of a crushed pollen-spore; *gn*, generative nucleus; *vn*, vegetative nucleus. × 356. Fig. 13, a cultivated pollen tube; *gn*, generative nucleus. × 356. Fig. 14, a pollen tube penetrating the stigma; *p*, *p*, papillæ of stigma. × 260. Fig. 15, a cellulose plug in a pollen tube. × 380. Fig. 16, a pollen tube penetrating to the embryo-sac; *p*, pollen tube; *s*, synergida disorganized; *kn*, *kn*^{1} (male and female pronuclei ?), the germ nucleus after its first division. × 356.



CAMPBELL ON PROTHALLIA.

The Development of the Prothallia of Ferns.[1]

BY DOUGLAS H. CAMPBELL.

(WITH PLATE IX.)

In the following paper an attempt has been made to present in brief form the results of a series of experiments upon the germination of the spores, and the development of the prothallia of some of the common ferns.

This subject was chosen for two reasons: first, because in the course of the experiments attention was called to several facts that do not seem to be generally known; and secondly, if possible, to arouse the interest of students of botany in a line of work that does not appear to receive the attention that it deserves.

The importance of the study of the development for a full understanding of any group of organic bodies is fully admitted, but there seems to be a prevalent idea that such study must necessarily be confined to the experienced and thoroughly trained biologist, whereas frequently many of the most important facts of development can be verified by any student of ordinary ability who knows how to handle a microscope.

The plants under consideration offer perhaps the best illustration of the point in question. Complex as is the structure of the mature fern, it starts from a single cell, the spore, and the earlier steps in the development of the plant from this cell can be traced with little difficulty. Of course the development of the sexual organs and the growth of the fern itself from the fertilized germ-cell is a much more difficult matter, but up to this point no difficulty is experienced.

There is no part of the country where some ferns do not grow, and the spores may either be sown at once or kept for future use, as they retain their vitality for a long time. They germinate quickly, and with a little care can be kept in a healthy condition and the successive steps in the development of the prothallium followed.

The first fern investigated by me was *Onoclea Struthiopteris*. After vain attempts to procure a sufficient number of fern-prothallia from green-houses, for study, and supposing that the germination of the spores was a long and difficult process, I determined to make some experiments. A quantity of the spores were gathered and sown without much hope of success, but in a few days undoubted signs of germination were evident, and soon

[1] Read before the American Association for the Advancement of Science, August, 1885.

a large number of healthy young prothallia was the result. Encouraged by this success, *O. sensibilis* was tried with similar results. Lack of time prevented following out the complete development of the prothallium, but subsequently both forms were grown and produced young plants. Other species, upon which more or less complete observations have been made, are *Asplenium Filix-fœmina*, *Aspidium spinulosum*, *A. acrostichoides*, *Adiantum pedatum*, *Cystopteris fragilis*, and *Woodsia Ilvensis*. Of these *Aspidium spinulosum* is frequently found growing naturally, as is also *Cystopteris*, but whatever observations were made upon the others were from artificial cultures. Spores were sown under various conditions, but the best results were obtained by simply sowing upon fine earth. The earliest stages can be more conveniently observed by sowing in water, but prothallia so grown do not maintain a healthy growth, and so far as my observations go, no sexual organs were developed upon them. Other cultures were made upon rotten wood, upon which they are frequently found naturally, and upon porous pottery, but in neither case was the result as good as when grown upon damp earth. In order to maintain an even degree of moisture, it was found best to keep the prothallia covered with a bell-jar, or some similar contrivance, as evaporation is too rapid when they are exposed to the air. Excess of moisture, especially after the prothallia are at all advanced, must be guarded against, as they will decay if kept too wet. The ground should be kept damp, but *not muddy*. Spores may be started at any time, but the best results are obtained by sowing in warm weather, or at least when they can be kept at a tolerably uniform temperature. In winter, even with artificial heat, growth almost ceases, the deficient light seeming to affect them unfavorably, as well as the lower temperature. Probably in a green-house, where the fluctuations of temperature are less marked, this would be less apparent.

By following the directions given, no trouble should be experienced in growing any of our common ferns.

The spores of ferns are protected by a thick brown exospore, usually marked by prominent thickenings or ridges. In many cases this exospore remains attached to the spore for a long time after germination. but in the genus *Onoclea*, it frequently becomes thrown off, being readily detached even when the spores are not fully mature. In this genus there is in addition to the exospore a second coat, which must be ruptured before the endospore proper can protrude. In ferns of other genera examined the exospore adhered so firmly to the spore as to make it impossible to determine whether this third coat was present or not.

The contents of the spore consist of dense protoplasm containing a nearly central nucleus, and numerous fine granules of chlorophyll. Oil is present, usually uniformly distributed, but sometimes collecting in large drops.

Ordinarily the first step in the active growth is an elongation of the spore, one end becoming nearly transparent. This transparent end elongates still farther and very soon is shut off by a septum approximately at right angles to the longer axis of the spore. Two cells are thus formed, a small transparent one, the first root-hair, and a larger one containing abundant chlorophyll. The root-hair contains only a few very small granules of chlorophyll, and these finally seem to disappear entirely. The walls of the root-hair frequently show a decided brown color, which is sometimes developed very early. This is noticeably the case in *Onoclea sensibilis;* in *Asplenium filix fœmina*, on the contrary, the color is scarcely apparent even in the older root-hairs. Abnormal cases occur where no root-hair is formed. The larger of the two cells first formed also elongates and very soon undergoes further division (Figs. 1–3). In the great majority the first division, and usually several successive septa, are parallel to the primary septum, thus giving rise to a filament, or single row of cells. The prothallium may never pass beyond this condition, especially if it is grown in water, but ordinarily, sooner or later, the terminal cell becomes divided by a septum nearly at right angles to the first ones (Fig. 4). Sometimes, again, the first wall in the body of the spore may be at right angles to the primary septum, and the prothallium never passes through the filamentous stage—this, however, appears to be exceptional (Fig. 4, a).

While the division of the cells is progressing, the chlorophyll granules which were small and crowded at first, become much larger and more widely separated. As the prothallium grows, they enlarge and divide, all of those to be found in the complete prothallium apparently arising from the growth and division of those that occur in the spore before germination.

After a varying number of divisions, one of the terminal cells assumes the lead and becomes a triangular apical cell, dividing by septa directed alternately right and left (Fig. 5–6, a). Occasionally two successive septa will be formed on the same side. As a result of the repeated divisions of this apical cell, the end of the prothallium becomes rapidly broader, but for a time the deep sinus in front, so characteristic of the prothallium, is not present. This arises as follows: each segment is first divided

by a septum perpendicular to the long axis of the prothallium; the outer of the two cells thus formed, or marginal cell, becomes next divided by a wall perpendicular to the first formed. These marginal cells lengthen, and the inner cell of the segment divides still further by walls parallel to the first. The segment thus grows faster in length than in breadth, and is rapidly pushed out beyond the apical cell, which thus gradually comes to lie at the bottom of an indentation or sinus in the front of the prothallium, and gives it the heart shape or kidney shape that the larger prothallia usually have. After a time, varying extremely even in the same species, the apical cell is divided into two cells by a vertical wall perpendicular to the long axis of the prothallium; the outer cell is next divided by a wall at right angles to the first, and from this time in the growth can no longer be traced back to one cell.

About this time, or sometimes before the obliteration of the apical cell, the cells in its vicinity, which had hitherto only divided in two planes, so as to form a single layer of cells, are now divided by walls parallel to the surface of the prothallium, forming the beginning of the cushion of tissue that occupies the base of the notch in the front of the prothallium; where this is begun early, the subsequent growth of the prothallium results in the formation of a thickened rib running through the middle for nearly its whole length.

The prothallium is fastened to the ground by numerous root-hairs that arise principally from the cells of the lower part, as small papillæ, that are soon shut off by a septum. Like the first one formed they contain little or no chlorophyll, and in most species soon acquire brown walls. They probably serve to some extent as absorbents as well as to fasten the plant.

In many species, e. g. *Aspidium spinulosum*, *Cystopteris fragilis*, *Onoclea sensibilis*, there are developed small papillæ from the marginal cells (Fig. 6. p.); whether these have any special function is extremely doubtful. They are entirely wanting in *Asplenium filix-fœmina*, and *Onoclea Struthiopteris*.

While the foregoing statements are true for the majority of cases, it must not be inferred that they are without exceptions; indeed, probably none of them are absolutely inflexible, and except in the earlier stages they are true only of the larger prothallia, which are, in most cases observed, female.

The subject of dicœcism in ferns is not, apparently generally understood; in fact, as far as I have been able to ascertain, while the formation of prothallia bearing only antheridia has been ob-

served, but apparently regarded as exceptional, the formation of strictly female prothallia has been overlooked. Of the ferns mentioned in this paper, three have been traced out with care, from the spore to the formation of the embryo, viz: *Onoclea Struthiopteris*, *O. sensibilis*, and *Asplenium filix-fœmina*, and in every case it was exceptional to find both sexual organs on the same prothallium. Asplenium offered the greatest number of exceptions, but even here it was rare. *Aspidium spinulosum*, to judge from naturally grown specimens, is monœcious, no undoubted male prothallia being found, and perfect antheridia occurring on the large prothallia. *Cystopteris fragilis* was found with two forms; small male prothallia, and large hermaphrodite ones. In regard to other forms, observations were too incomplete to warrant any statements on the subject.

The male prothallia of all the forms observed are, as a rule, very much smaller than the female, and frequently of very irregular shapes (Figs. 8, 9, 10). Either no definite apical cell is formed, or it is early lost. Where the spores are sown thickly it is not uncommon to find the prothallium reduced to a single row of cells terminated by an antheridium, other antheridia being formed laterally in some cases, in others not.

The simplest form observed was that of *Asplenium filix-fœmina*, where a number of prothallia were formed whose vegetative portion was reduced to a single cell besides the root-hair (Fig. 7). A single antheridium was formed in each, and perfect antherozoids.

Under favorable circumstances the spores germinate in from three to five days, but in cold weather, or with imperfect spores, the time was indefinitely lengthened. The first antheridia were usually mature in about five weeks from the first signs of germination, but in one case, Asplenium, ripe antheridia were formed in a little more than three weeks from the sowing of the spores. Spores sown August 31 produced ripe antheridia on September 23. The prothallia in this case were reduced to a very few cells. Spores of *Onoclea Struthiopteris*, sown on February 25, 1884, began to grow upon March 3d, produced the first ripe antheridia April 9th, and the first mature archegonium, April 30th.

As an instance of the vitality of the spores, one example will suffice. Specimens of *Woodsia Ilvensis* were collected upon Lake Superior in July, 1883, the fronds were dried for the herbarium, and laid aside. In October, 1884, a number of the spores were placed in water, and in about a week began to grow.

Under proper conditions the prothallia will live for compara-

tively long time. Cultures were made of *Asplenium* and *Onoclea Struthiopteris* in 1884, from spores sown August 31. They grew rapidly and soon developed quantities of antheridia, but in the case of *Asplenium*, *no archegonia*. As cold weather came on, although the prothallia were kept in the house, growth ceased almost entirely, but was resumed in the spring, the prothallia appearing perfectly healthy. Large numbers then developed archegonia, and subsequently young plants, but some of them are still (August 14) perfectly vigorous, and growing.

The older male prothallia assume very irregular forms, reminding one somewhat of the prothallia of *Equiseta*, but the female retain nearly the same form as they have when young although they may be slightly irregular.

The sexual organs continue to form as the prothallia grow, so that in the older ones the number is very large. A female prothallium of Asplenium, about one cm. in diameter, examined August 12, had over one hundred and twenty-five archegonia, but no antheridia. One of the archegonia had been recently fertilized, but the remainder were abortive. It sometimes happens that several archegonia will be impregnated, but only one embryo apparently ever develops perfectly.

In the older prothallia of *Onoclea Struthiopteris*, especially early in the spring, large quantities of starch were observed.

EXPLANATION OF PLATE IX.—Figs. 1–5, successive stages in germination of the spore of *Onoclea sensibilis*. × 150. Fig. 6, an older prothallium of the same, showing the apical cell (a), and marginal papillæ (p). × 80. Fig. 7, very small male prothallia of *Asplenium filix-fœmina* antheridia (a). × 150. Figs. 8–9, large male prothallia of the same. × 150. Fig. 10, a male prothallium, about three months old, of *Onoclea Struthiopteris*. × 60. Fig. 11, mature prothallium of *Cystopteris fragilis*. × 5.

On the Appearance of the Relation of Ovary and Perianth in the Development of Dicotyledons.[1]

BY JOHN M. COULTER.

Two years ago I read before this section a paper upon the "Development of the Dandelion," an organogenic study, in which it incidentally appeared that the first character to show itself was that of the inferior ovary. Since then this hint has been some-

[1] Read before the American Association for the Advancement of Science, August, 1885.

what extensively followed up, and the results form the reason for the present paper.

It is well enough known that botanical classification is in a transition state, that the published systems of classification are even far behind our knowledge, and that our knowledge is very far from what it ought to be. Sooner or later everything artificial must be abandoned and the natural substituted for it. It is a matter of great congratulation among botanists that Bentham & Hooker were permitted to finish their magnificent "Genera Plantarum," but it is also to be regretted that they have rendered still more rigid certain groupings which should plainly have been abandoned.

It is very far from the object of this paper to suggest a new scheme of classification, for an appalling array of facts must first be accumulated, but simply to record some observations which seem to have their bearing upon the solution of this difficult problem.

One of our greatest grievances has been the persistent displacement of Gymnosperms, whose true position both their floral organs and paleontology have long since pointed out, but this paper is chiefly concerned with the group Dicotyledons. Here the artificial grouping into Polypetalæ, Gamopetalæ, and Apetalæ has become threadbare and worn from long use, and in the present state of our knowledge it is worse than useless to attempt to patch it up. Although confessedly artificial it distorts relationships in too plain a way and draws down upon us the criticism of the most superficial. The group Apetalæ, intercalating most intricately with Polypetalæ, is yet separated from them by Gamopetalæ, which are much more highly developed than either.

As embryology has been of such invaluable aid in Zoölogical classification, it is but reasonable to suppose that organogeny may be able to play some such part in botany.

Upon the discovery that the inferior ovary was the first character to appear in the development of the dandelion flower, I began a somewhat extensive examination of the larger dicotyledonous families, to discover how the character was sustained. The fact was recognized that the dicotyledonous character was first to appear in the plant life, and hence it seemed that development shows no more natural grouping of Angiosperms than into Dicotyledons and Monocotyledons.

About one hundred and fifty species were examined, from the very earliest stages of the flower to its full development, belonging to the following eleven orders: Ranunculaceæ, Leguminosæ

Rosaceæ, Saxifragaceæ, Onagraceæ, Rubiaceæ, Umbelliferæ, Compositæ, Borraginaceæ, Scrophulariaceæ, and Labiatæ. The result was that in every case the first recognizable character was that of inferior or superior ovary, and a most simple grouping on that basis was apparent.

The appearance of this character in development can be told in a few words. In the case of an inferior ovary, the protuberance which is to develop into the flower is arrested in its axial development, grows peripherally into a collar, and soon there appears an external constriction, distinguishing the nascent floral envelopes above from the ovary below. The character of an external constriction is always the most readily recognized, and is as sure a mark of an inferior ovary as the harder seen arrest of axial development.

In the case of a superior ovary, the axial development is continued, and there is no external constriction. All this is perfectly clear before there is a possible recognition of any other floral character.

It may be instructive to look at a few of the results of such a basis of classification. Naturally, if organogeny means anything, the plants with inferior ovaries must be regarded as more highly and more recently developed than those whose flower parts are hypogynous. Hence Compositæ, Umbelliferæ, Rubiaceæ, Onagraceæ, and their various appendages would stand together as of highest rank, the first named order for some time having been considered the most highly developed. The resemblances between Compositæ and Umbelliferæ other than that of an inferior ovary are very suggestive.

In all natural classification there is a limbo of intermediate forms whose relationships are not so hard to discover as to arrange, and the cases of ovaries neither decidedly superior nor inferior are very familiar to every botanist. In such an intermediate place would stand the orders Rosaceæ and Saxifragaceæ, whose mutual boundary wall has already broken down.

In the group with superior ovaries there would appear such orders as Leguminosæ, Scrophulariaceæ, Labiatæ, etc., great groups with irregular flowers, and probably representing the highest development of dicotyledons with superior ovaries. Following these, and intergrading with them, appears the polymorphous order Ranunculaceæ, and so on.

In the terms of our present classification, such a grouping would result somewhat as follows:

Ovary inferior.	}	Some Gamopetalæ and Polypetalæ, such as Compositæ Umbelliferæ, Rubiaceæ, Onagraceæ, etc.
Ovary superior.	{	Some Gamopetalæ and Polypetalæ, such as Leguminosæ, Scrophulariaceæ, Labiatæ, etc., and Apetalæ.

It must be distinctly understood that the above does not present a proposed classification, but simply traces some of the probable results of organogenic study.

It is of no small consequence in these days to obtain the testimony of paleontology in favor of any system of classification. The order of appearance of Phanerogams is well known; first, Gymnosperms, then Monocotyledons, long afterward Dicotyledons, and the last Dicotyledons were those with inferior ovaries. From such great composite groups as Compositæ, therefore, the flora of the future is to be worked out.

GENERAL NOTES.

Results of the Ann Arbor Meeting.—This meeting gave more than the usual opportunities for becoming acquainted and benefited by the society of the members during the intervals between the regular sessions, owing to the short radius within which the members found entertainment, and the fewer distractions than in the case of large meetings, with their multiplicity of excursions and receptions. This advantage was made good use of by most, and it is safe to say that, so far as the botanists are concerned, no former meeting has yielded such full and satisfactory returns in this regard.

The attendance of botanists was unexpectedly large, and gives assurance of the continued prosperity of the club.

The efforts of the club from the beginning have been directed toward raising the standard of the botanical papers presented to the Association, and it is gratifying to note that this is actually being accomplished. It is certain that as a whole the botanical papers of this year will compare more favorably with those presented in other departments of biology than at any previous time. This is both because the papers are actually better than usual, and because the less weighty ones have been sifted out. These siftings found appropriate presentation before the club, where they met a sympathetic audience ready to turn to good use every morsel of value they contained. The total result is that the Association gets better botanical papers, and the botanists get through the club more items, notes and news than heretofore.

The committee of the Association on the encouragement of researches on the health and diseases of plants reported that the first and very important object in view had been accomplished. This was the recognition from the Commissioner of Agriculture of the need of work of this kind and some provision for its prosecution at Washington. Commissioner Colman, upon receiving the

first memorial of the committee, at once appointed Mr. Scribner, of Girard College, well known as an accurate botanist, to devote his whole time to this kind of work. The committee then sent Mr. Scribner the assurance of their cooperation in developing this new feature of the Department. Commissioner Colman has since shown in many ways his belief in the value of the work proposed by the committee, and his determination to prosecute it as fully as circumstances will permit. The committee, which consisted of seven members, was found to be unwieldy, and the desirability of having at least one member a resident of Washington was urged. For these reasons it was reorganized, and the following members selected for the coming year: J. C. Arthur, of Geneva, N. Y.; C. E. Bessey, of Lincoln, Neb.; W. G. Farlow, of Cambridge, Mass.; T. J. Burrill, of Champaign, Ill.; and C. V. Riley, of Washington, D. C.

The Botanical Club adopted a resolution supporting Commissioner Colman in this work, and offering to exert their influence with their respective Congressmen to secure a suitable appropriation.

The committee of the Association on postage for botanical specimens reported that the matter had been suitably presented to the Postmaster-General, who made the desired recommendation to Congress, which may be found on page 15 of his Annual Report for 1883–4, but that owing to the rush of business at the close of the session it was neglected. They think there will be no difficulty, however, in securing its passage at the coming session, thus permitting herbarium specimens, accompanied with the usual label, whether written or printed, to go at fourth class rates of postage. The committee, consisting of L. F. Ward, Geo. Vasey, and J. W. Chickering, was continued.

The action of the club in regard to the relationship of the botanists of the country to the national herbarium is given elsewhere in the account of proceedings of the club.

The discussion of the highly important subject of a uniform nomenclature of English names of plant diseases and of disease producing fungi has also been given in the proceedings of the club. The committee to investigate the subject is composed of J. C. Arthur, W. G. Farlow and W. Trelease.

Plants of the Greely Expedition.[1]—List of plants collected in the summer of 1882 and 1883, by Lieut. A. W. Greely and members of the L. F. B. Expedition, in the vicinity of Fort Conger, Grinnell Land, situated in lat. 81° 44′ N., long. 64° 45′ W.:

1. Ranunculus nivalis R. Br. var. sulphureus Wahl. From the sea level to 1,800 ft. 5 to 7 in. high.
2. R. affinis R. Br. 1,800 ft. alt. 5 in. high.
3. Papaver nudicaule Linn. Sometimes nearly white flowered.
4. Cochlearia officinalis Linn.? 1 to 3 in. high.
5. Braya alpina Sternb. var. glabella. (*B. purpurascens* R. Br.)
6. Vesicaria arctica Rich. Sea coast to 1,000 ft. alt. The largest specimen 4 in. high and spreading 6 to 7 in. wide.
7. Parrya arenicola Hook. f.?
8. Eutrema Edwardsii R. Br.

[1] Read in part before the Botanical Club of the A. A. A. S., at the Ann Arbor meeting, August, 1885.

9. Cheiranthus pygmæus Adams. (*Hesperis pygmæus* Hook.) From 50 to 1,000 alt. The specimens are young and mostly less than 2 in. high, the largest 6 in. A few found with stem and pods of two preceding years' growth.
10. Draba hirta Linn. (*D. arctica* Vahl.) 2 to 3 in. high.
11. D. rupestris R. Br.
12. D. alpina Linn. In flower June 16.
13. Lychnis apetala Linn. From the coast to 1,000 ft. alt. The specimens from 1 to 5 in. high, rarely 2 or 3 flowered.
14. Lychnis triflora R. Br. With the preceding, the stem and leaves more pubescent, mostly 1 flowered, rarely 2 or 3 flowered.
15. Arenaria Grœnlandica Spring.? In leaf only.
16. A. verna Linn. var. hirta. 200 to 1,000 ft. alt.
17. Cerastium alpinum Linn. (*C. lanatum* Lam.)
18. Stellaria longipes Goldie, var. Edwardsii T. & G. From the sea to 1,000 ft. alt. 2 to 4 in. high.
19. Potentilla nivea Linn. Coast to 1,000 ft. alt. 2 to 5 in. high.
20. P. nivea, var. quinata Lange.
21. P. pulchella R. Br.
22. P. maculata Pourr.
23. Dryas octopetala Linn. var. integrifolia. Coast to 1,000 ft. alt. The specimens are 1 to 2 in. high, leaves mostly entire, sometimes minutely toothed. The most common plant found, beds of acres in extent being frequent, especially in the interior. Often with many petals.
24. Saxifraga oppositifolia Linn. Coast to 1,900 ft. alt. Flowers from 4 to 9 petaled, varying from pink to dark purple.
25. S. flagellaris Willd. 1,200 to 1,800 ft. alt., generally 1 flowered.
26. S. tricuspidata Retz. Not found below 800 ft. alt. 2 to 4 in. high.
27. S. cæspitosa Linn.
28. S. nivalis Linn. Found between 800 and 1,200 ft. alt. Specimens mostly 2 to 3 in. high, some found as high as 6 in.
29. S. cernua Linn. From 200 to 1,800 ft. alt. 3 to 8 in. tall.
30. S. rivularis Linn. var. hyperborea Hook.
31. Epilobium latifolium Linn. Coast to 1,200 ft. alt. Found only on rocky soil. Specimens from 2 to 4 in. high.
32. Erigeron uniflorus Linn. Coast to 800 ft. alt., becoming larger at the higher altitudes. Specimens 2 to 5 in. high.
33. E. compositus Pursh, var. trifidus Gr. From 100 to 800 ft. alt. Specimens from 1½ to 3 in. high, generally 1 flowered.
34. Arnica alpina Olin. Coast to 1,500 ft. alt. 2 to 6 in. high.
35. Taraxacum officinale Web. var. lividum Koch. Coast to 200 ft. alt. 2 to 4 in. high, two shades of color, deep yellow and yellowish-white.
36. Cassiope tetragona Linn. From 100 to 500 ft. alt.
37. Androsace septentrionalis Linn. 50 to 500 ft. alt.
38. Pedicularis capitata Adams. From 100 to 700 ft. alt.
39. P. Langsdorffii Fisch. var. lanata Gr. From 50 to 100 ft. above the sea, in company with Dryas.
40. Oxyria digyna Camp. Specimens from 5 to 7 in. high.
41. Polygonum viviparum Linn. From 100 to 800 ft. alt.
42. Salix arctica Pall. Coast to 1,800 ft. alt. From 1 to 1½ ft. in length.
43. Luzula hyperborea R. Br. (*L. confusa* Lindb.)
44. Juncus biglumis Linn. Margin of small ponds. 3 to 6 in. high.
45. Eriophorum angustifolium R. Br. 800 to 1,200 ft. 3 to 8 in. high.
46. Kobresia scirpina Willd.
47. Carex nardina Fries.

48. C. rupestris All.
49. C. ustulata Wahl. var. minor Boott.
50. C. vulgaris Fr. var. hyperborea Boott.
51. Alopecurus alpinus Linn. Specimens from 4 to 18 in. high.
52. Arctagrostis latifolia Gris. Coast to 800 ft. alt. From 5 to 6 in. high.
53. Deschampsia brevifolia R. Br. (*Aira arctica* Spr.) Specimens from 2 to 4 in. high. Not the *Aira arctica* of Rothrock's Flora of Alaska, nor *Aira cæspitosa*, var. *arctica* of authors.
54. Trisetum subspicatum Beauv. Coast to 800 ft. alt. From 3 to 7 in. high.
55. Poa cerisia All. (*P. arctica* R. Br.) From 2 to 5 in. high.
56. P. abbreviata R. Br.?
57. P. alpina Linn. var. vivipara.
58. P. laxa Haenke. Specimens 3 to 8 in. high.
59. P. cæsia Smith, var.
60. Festuca rubra Linn. var. From 3 to 5 in. high.
61. Agropyrum violaceum Hornm. From 2 to 7 in. high.
62. Equisetum variegatum Schl.
63. E. arvense Linn.
64. Cystopteris fragilis Bernh. Coast to 1,300 ft. From 3 to 6 in. high.

"PUCCINIA CHEIRANTHI, Ellis & Everhart (n. sp.) On *Cheiranthus pygmæus*, Grinnell Land.

"III. Sori hemispheric, brown, naked, ½ to ¾ mm. in diam., thickly scattered over both sides of the leaves, but (in the specimen examined) not confluent. Spores oblong or clavate-oblong, light brown, constricted at the septum, 35–53×15–22μ, either consisting of two subequal cells or oftener the upper cell broader and shorter (subglobose) and the lower one tapering into the stout, rather persistent pedicel, which is about as long as or a little longer than the spore itself; epispore smooth or faintly but rather coarsely roughened above, thickened and lacerated at the apex so as to resemble somewhat the remains of the calyx on a currant or huckleberry.

"I. and II. not seen. This appears to be sufficiently distinct from the other species on the *Cruciferæ*."

I am indebted to Prof. Watson and Dr. Gray for the determination of some of the species included in the list.—GEO. VASEY.

Botanical Features of New Brunswick.[1]—There are two striking physical features of the Province which affect its flora in a marked degree. Its southern shore is a wall of rock, veiled in cold mists of fogs from the Bay of Fundy. Interspersed here and there between these fog-bound hills are peat bogs and evergreen forests, whose flora is of the most boreal type. The average summer temperature is not more than 58°. In the summer of 1884 I had an opportunity to compare the flora of the hills about St. Johns, in lat. 45°, with an inland mountain peak in the northern part of the Province, in lat. 47°, with an altitude of 2,240 feet. The flora in each case was strikingly alike, with an advantage perhaps in favor of the top of the inland peak. Along the outer face of these cliffs that border on the Bay of Fundy, and filling the clefts of the rocks, are reddish colored tufts of *Sedum Rhodiola*. Chief among the plants of

[1] Read before the Botanical Club of A. A. A. S., at the Ann Arbor meeting, August, 1885.

the peat bogs is the Cloud Berry (*Rubus Chamæmorus*), while the ground is covered in many places with *Empetrum nigrum* and *Vaccinium Vitis-Idæa;* and *Potentilla tridentata* with its bright blossoms makes cheerful many a dull rocky crag. These, with many other boreal types, find a genial home in the low temperature and fog-laden atmosphere of the extreme south of New Brunswick, while hidden away still deeper in the clefts of the limestone rocks and generally on the northern sides, is the pretty little *Asplenium viride*, but with no trace as yet in this Province of its congener, *A. trichomanes*.

But the second physical feature is the great valley of the St. John river and its tributaries, whose flora is far more southerly in character than that above enumerated, although in its northern portions it has many striking boreal forms. In the rich alluvial bottoms of the St. John and its tributaries I have seen *Struthiopteris Germanica* six and seven feet high. Along the Tobique river I saw *Osmunda regalis* growing to the height and profusion to which alders grow on the borders of other streams. I have before me a tuft of *Elymus Canadensis* nine feet in height, collected at Eel river, one hundred miles from the mouth of the St. John. In the rich intervals there are *Sanguinaria Canadensis, Asarum Canadensis, Caulophyllum thalictroides, Adiantum pedatum*, and others whose growth would be impossible were it not that the cold fogs of southern New Brunswick have been dissipated by the sunshine which reigns here day after day, and that the rocky coasts have given place to alluvial meadow and green field. One other feature of this St. John river valley may be referred to. Rising from the famous Aroostook region of Maine it bears upon its waters the seeds of many plants, which are peculiar to this river so far as American botany is concerned. Among these may be mentioned *Oxytropis campestris, Astragalus alpinus, Hedysarum boreale, Tanacetum Huronense* and others.—GEO. U. HAYS.

Society for the Promotion of Agricultural Science.—The sixth meeting of this society was held at Ann Arbor the day preceding the meeting of the A. A. A. S., and was unusually good, both in point of attendance and character of the papers presented. The first paper was read by Mr. J. J. Thomas, of New York, upon the influence of locality upon the varieties of fruit. The writer opposed the very prevalent view that fruit raised in our own country is on that account better suited to our cultivation. In the discussion Dr. Sturtevant called attention to the fact that any fruits are most highly flavored in their most northern localities, and larger and finer looking toward the south. He suggested the influence of actinism as a possible explanation. The two following papers were by Dr. E. L. Sturtevant, of New York, upon the dandelion and lettuce. It was an attempt to prove that the forms of cultivated plants are selected wild types rather than forms originated by culture. Prof. C. E. Bessey, of Nebraska, read a paper upon the demands made by agriculture upon the science of botany. The demands are as follows, and any of our professional botanists who may be seeking new fields of work, can give them some serious thought:

1. A nomenclature and classification of the plants of the farm, cultivated as well as wild.
2. A better knowledge of the physiology of plants, including such sub-

jects as growth and nutrition, fertilization, heredity, and the physiology of cultivation and improvement.

3. A better knowledge of the pathology of plants, particularly of that ill-defined state known as "lowered vitality."

By all of which is meant not only that botanists should learn more concerning the subjects mentioned, but also that students should be better taught the little we do know about them.

Prof. T. J. Burrill's paper upon an experiment in silk culture was chiefly concerned with a contagious disease which destroyed the worms. This he identified as the *flacherie* of Pasteur, probably the first recognized existence of this disease in America. The other papers were not botanical, except a short report by Prof. W. J. Beal, upon the progress of certain experiments upon the vitality of buried seeds. The officers elected for next year are Henry E. Alvord, president, and B. D. Halsted, secretary and treasurer.

Some Nasturtium Leaves.—One day last month, when plucking a bunch of garden Nasturtiums (*Tropæolum*) I observed two small abnormally shaped leaves on one lateral stem. They were spatulate in form, and each was about 1⅝ inches in length, the blade of one an inch long, and its petiole five-eighths of an inch; while the other had the stem relatively a little longer. A third leaf, only three-fourths of an inch in diameter, was normally peltate. The branch was in flower.

On an other occasion I found another Nasturtium leaf (one and one-half in. diam.) that was round reniform, with the margin of the leaf at its base not brought together and united, the petiole being attached to the blade at its base, instead of being attached on the under surface of the leaf, as with this plant usually. This form might, I should think, illustrate the evolution of the peltate leaf from a rounded leaf by the joining together of the lower margin. The spatulate leaves would, however, require more modification, the blade of the leaf needing to be much widened and extended at its base into lobes before the margins could coalesce into the shield-shaped form.—Rosa Smith, *San Diego, Cal.*

Notes on Black Knot.—These notes of occasional observations on *Plowrightia* (*Sphæria*) *morbosa* this season may be worth saving, as they differ in some particulars from what has been recorded.

The first examination was January 6, when the asci were found considerably developed and spores beginning to form. By the first of March most of the asci contained spores, but they were still unripe. Development continued slowly until warm weather, then more rapidly until the middle of May, when spores were the most numerous. Most of the spores now had thicker, dark-colored walls, were apparently ripe, and some were being discharged. Ascospores continued to be formed in perithecia which were in depressions of the knot, until June 17, when the new knots were well advanced and bearing conidia.

The mycelium stimulates to excessive development the growth of the year, which, bursting the older bark, permits the fruit of the parasite to form at the surface of the living tissue thus exposed. With the excessive development the

tissues lose their character somewhat, but when the knots are young the distinction between bark and wood still exists, the cambium line being deflected outward through the knot.

Knots on the wild plum in this vicinity contain no live perithecia so far as seen, and the same is often the case with the cultivated plum. In a few instances the knot was found on *Prunus serotina*. It has not yet made its appearance in the orchards in the northern part of the state.—A. A. CROZIER, *Ann Arbor, Mich.*

The Æcidium of Adoxa.—The *Adoxa Moschatellina* L. grows abundantly in some localities in northern Iowa, where it is much infested with the *Æcidium albescens* Grev. According to European botanists this fungus is a state of *Puccinia Adoxæ* DC. Teleutospores have not, however, been found in America, and it is not easy to account for the abundant æcidium without them. It has been suggested that the æcidium might be perennial in the subterranean stems of *Adoxa*. To test this some plants were forwarded in the spring of 1884, through the kindness of Mr. E. W. Holway, to Geneva, N. Y., which were thoroughly covered with cluster cups. They were potted and placed in the green-house, and up to the time the leaves normally disappeared continued to bear the æcidium. When cold weather approached the pot was sunken out of doors, where it remained until the following March. It was then placed in the green-house and the plants at once started into vigorous growth. Perfectly healthy and rich foliage succeeded, and in due time numerous rhizomes were pushed out beneath the soil, but up to the present month no æcidium whatever has appeared. This seems to prove quite conclusively that *Æcidium albescens* is an annual. The plants were removed a thousand miles from their nearest locality and grown normally, except that they were induced to start some weeks before the usual time in the spring, and no cluster cups appeared. How the æcidium tides over the long interval from one season's activity to another is as great a problem as ever.—J. C. A.

Notes on Florida Lichens.—During my annual winter sojourn in Florida I was somewhat at a loss as to what sort of plants should receive attention. I had time and again collected most of the flowering species to be found from December to March. Arriving in Jacksonville about Christmas and having put my house in order, I was ready for active work. I could not neglect my old friends, the Phanerogamia, and numerous excursions resulted in my collecting nearly one hundred species, all old acquaintances, but several, as *Verbesina heterophylla*, *Polygala grandiflora*, and *Bigelovia nudata* were a novel sight even here in midwinter. *Heterotheca Lamarckii* was very common in old fields. Several species of *Chrysopsis* were also abundant. The foregoing were evidently late bloomers of the fall. During my daily rambles through the pine barrens and the hardwood hummocks I had been looking around for some new field of investigation and this seemed to be offered me in the extraordinary abundance of Fungi and Lichens. To use a common expression, "the woods were full of them," and I was reminded of my mushroom-eating friends at home whom I had seen wandering around barn yards and fields in early morn and to whom,

possibly, I stand indebted for giving me hints on this subject. I began collecting, and the results show one hundred and sixty species obtained within a few weeks, and all collected at no greater distance than two miles from my home. For names I am under obligations to Mr. Ellis and Mr. Willey, both well known specialists. Of the species collected four are supposed to be new. The Lichen flora I found everywhere in the greatest abundance—living trees being the favorite resort of the smaller and less conspicuous species. It has been supposed that the Lichens flourish best in a cool, dry climate. Florida is perhaps an exception. I collected about eighty species and am confident that as many more can be found within the state. The field is an inviting one for lichenologists. As I am only an amateur I can not do as much as I might in different circumstances. One of the first forms to attract attention is *Usnea barbata*. This clings in profuse masses from the trunks of *Taxodium* in swamps. The *Cladonias* affect the earth and old logs, always in damp situations. On the leaves of *Osmanthus Americana* and *Magnolia grandiflora* the *Strigula complanata* is common. Not a few species are West Indian and tropical. The accompanying list shows partially what can be done by a little effort in a very short time. Thus far I have found none of the species except Cladonias restricted to any particular habitat, as to trees. The oaks being most plentiful sustain the greater number.—W. W. CALKINS.

[The writer appends a list of 76 species and varieties collected by him, for which we can not take space. This list will doubtless be furnished gladly to those interested in the geographical distribution of lichens.—EDS.]

Second Blooming of Catalpa.—On one of the streets of Mt. Carmel, Ill., stand two large trees of our local native Catalpa (*C. speciosa*, Warder). During the first week in June they were both in full bloom. These flowers all dropped during the first half of that month. To-day, July 20, one of them is again in full bloom. The whole top is literally covered with flowers, and at the same time the beans of last month's flowers are hanging thick. In this second crop the panicles are about as large and full as in the first. The flowers are of the usual size, but a little paler. It is so unusual for a second flowering to be apparently as abundant as the first, that I think it proper to report this instance. Another peculiarity is the short time between the two crops—about six weeks.

—J. SCHNECK, *Mt. Carmel, Ill.*

Ferns of Petoskey.—Within four miles of this popular Michigan summer resort may be found the following: Pteris aquilina, in open ground; Botrychium Virginicum, widely distributed; Cystopteris bulbifera, on springy hillsides; Asplenium angustifolium and Filix-fœmina, not common; Osmunda Claytoniana, in a single locality; Phegopteris Dryopteris, rather common; Aspidium spinulosum, variable and fine, wooded hills everywhere; A. Thelypteris, marshes; A. cristatum, and Goldianum, scarce; A. marginale, fine, and rather common; Adiantum pedatum, dry knolls in woods, abundant and fine.

—A. A. CROZIER.

EDITORIAL NOTES.

DR. GUSTAV W. KÖRBER, lichenologist, died July 28, at Breslau, in his sixty-ninth year.

DR. H. W. REICHARDT, of the University of Vienna, died on August 2, at fifty years of age.

DR. E. KOEHNE, of Berlin-Friedenau, is now editor of the *Botanischer Jahresbericht*, succeeding Professor Just.

THE GAZETTE was the only purely botanical paper represented. The entire editorial staff was there, "taking notes."

DR. ASA GRAY asks that botanists, who can do so conveniently, will send him seeds of *Coreopsis aristosa*, *Baptisia leucophæa*, and *B. leucantha*.

MR. CHARLES WRIGHT, the botanist and explorer, died at Wethersfield, Conn., August 11, at the age of seventy-four.

THE AMERICAN SOCIETY OF MICROSCOPISTS will hold its 1886 meeting at Chautauqua, N. Y. Prof. T. J. Burrill, of Illinois, is president for the coming year.

DR. H. MAYR, teacher in the University at Munich, is taking a four months' journey in America to study the forest vegetation, as we learn from the *Botanisches Centralblatt*.

MR. A. B. SEYMOUR takes the place in the University of Wisconsin vacated by Prof. Trelease. Mr. Seymour has heretofore been connected with the Botanic Gardens at Cambridge.

PROF. BESSEY calls attention to the fact that the styles ("silk") of Indian corn furnish excellent studies in protoplasmic activity. Young styles should be taken from an ear which has been kept in a warm place for an hour or so.

A DISTINCT odor has been noticed by Plowright in the spermagonia of *Puccinia Vincæ* growing on the large periwinkle. It may yet be shown that the spermagonia of the *Uredineæ* attract insects to some purpose.

THE SEPTEMBER NUMBER of the *Journal of Mycology* is devoted to an enumeration of the North American species of the genus *Glœosporium* by Ellis and Everhart. Forty-seven species are described with index of species and host plants.

PHOTOGRAPHS recently received of the new Botanical Garden of the University of Liége show most complete and elaborate grounds and buildings, and the botanist's European trip will no longer be complete without a visit to Prof. Edouard Morren.

AMONG BOTANISTS present were M. S. Bebb, W. J. Beal, E. W. Holway, C. E. Bessey, L. H. Bailey, Jr., V. M. Spalding, W. R. Lazenby, L. M. Underwood, D. H. Campbell, C. F. Wheeler, E. F. Smith, T. J. Burrill, B. D. Halsted, J. J. Davis, Miss L. J. Martin, J. F. James, F. L. Scribner. An inspection of the full list (of which the above is a small fraction) shows that the western botanists were out in force.

THE BROOKVILLE (IND.) SOCIETY OF NATURAL HISTORY is a very active organization, and has just published its first bulletin. The exogenous flora of Franklin county, by O. M. Meyncke, and a list of diatoms, by Dr. E. G. Grahn, are the papers of botanical interest.

DR. FRANKLIN B. HOUGH, well known in this country and Europe for his interest in forestry, died at his home in Lowville, N. Y., June 9, in his sixty-third year. He gave considerable attention to phanerogamic botany, one of his earlier works being an account of the flora of Lewis county, N. Y.

DR. FREIHERR VON BRETFELD, recent botanist to the Agricultural Experiment Station at Halle, Germany, has just accepted the professorship of agricultural botany at the Polytechnikum at Riga. He has recently published an excellent work of 250 pages on the physiology of plants in relation to agriculture.

THE PRESENCE of nuclei, chromatophores and pyrenoids in several members of the *Phycochromaceæ* has been demonstrated by Hansgirg in a paper before the German Botanical Society. They occur in the lower members of the order, while the higher groups, the *Lyngbyeæ*, *Calotricheæ*, and *Scytonemeæ*, appear to have none.

A LIST of European Carices, by Dr. H. Christ, published in the "Comptes-rendus" of the Royal Botanical Society of Belgium, shows 151 species, grouped under 36 sections. There are 98 species and 21 sections of Heterostachyæ; 37 species of Homostachyæ; 2 species of Cephalophoræ; and 14 species of Monostachyæ.

A COMMITTEE has recently been appointed in France to obtain sufficient money to erect a monument to Pierre Belon, a naturalist of the sixteenth century (1517–1564), who did good work for the botany of that day. *La Belgique Horticole* for January and February is largely made up of an account of Pierre Belon, his life and works, accompanied by a portrait engraved in the year 1855.

THE MARRIAGE OF Dr. N. L. Britton and Miss Elizabeth G. Knight, of New York City, occurred on the 27th of August. Both are well known botanists, and the fact of their marriage was made known to the Botanical Club of the A. A. A. S. by the chairman as a matter of botanical news. The club received the announcement with applause, and immediately ordered a congratulatory telegram sent to Dr. and Mrs. Britton.

IN THE FIRST TWO FASCICLES of the *Annuario del R. Instituto Botanico di Roma* for 1885 are some most excellent contributions, accompanied by fine plates. Prof. Pirotta writes concerning the comparative anatomy of certain leaves; also the laticiferous and assimilative systems of certain plants. P. Baccarini contributes a paper upon plant coloring. C. Avetta has made an anatomical study of the vegetative organs of *Pueraria Thumbergiana* (an Asiatic species of Leguminosæ).

SCIENCE gives an excellent account of the Ann Arbor meeting of the American Association in its issue of September 11 (40 pp.), each section being reported with great completeness, when the necessarily limited space is considered.

We would offer but one criticism, and that is the unnecessarily harsh way in which reference is made to the merging of "Microscopy" into Biology. As Section G asked for the change, and thus acknowledged its own unnatural existence, the "I-told-you-so" was hardly courteous.

A REVISION of the N. Am. species of the genus *Scleria*, by Mr. N. L. Britton, has just been published in the Ann. N. Y. Acad. Sci., Vol. iii, No. 7. Mr. Britton has long been at work upon Cyperaceous plants, and it is to be hoped that this brief paper is but a prelude to the promised revision of *Cyperus*. Eleven species of *Scleria* are characterized, none of them new, with full bibliography, synonymy, and range. *S. laxa* Torr. becomes *S. Torreyana* Walpers, while several new varieties are added to the other species of the Manual.

MR. J. G. BAKER, in the *Journal of Botany* for September, gives a synopsis of the Cape species of the Liliaceous genus *Kniphofia*, with descriptions of five new species. The genus is strictly South African, including Madagascar, and this synopsis shows eighteen species. The same author, in the same journal, gives a classification of garden roses, which is surely something sorely needed. It may be necessary, as suggested at Ann Arbor last August, for systematic botanists to turn more of their attention to a classification of cultivated plants.

MR. THOMAS HICK, in the *Journal of Botany*, notes the results of a study of "the Caulotaxis" of British Fumariaceæ. By "caulotaxis" is meant the arrangement and relation of the central and lateral axes of a plant. The axis of these plants is generally sympodial, and the excellent plan was adopted of studying the formation of this pseudaxis in developing plants. As a result it was plainly seen how the leaf-opposed flower clusters are really terminal, pushed aside by a more vigorous branch, a result which exactly accords with the theoretical statement of our text-books.

WE COMMEND the effort of Queen & Co., of Philadelphia, to produce a serviceable laboratory microscope. In the August number of their *Microscopical Bulletin* (an excellent little journal, by the way) they ask teachers to communicate their opinion regarding the most desirable form of instrument, and state the reasons why preferred. Bausch & Lomb, of Rochester, have for some time tried to meet the demand for a suitable laboratory microscope. It looks as if our instrument makers were waking up, and would not much longer force us to import from foreign makers, when a stand is wanted for common daily use.

MR. A. A. CROZIER, of the University of Michigan, has published a thesis bearing the title, "The Modification of Plants by Climate." It has brought together a great amount of scattered material upon this interesting subject, and, not the least valuable part of the paper, a full bibliography is given. Summing up the whole matter, the conclusion reached is as follows: "It seems to be established that as plants move from the locality of their largest development toward their northern limit of growth they become dwarfed in habit, are rendered more fruitful, and all parts become more highly colored. Their comparative leaf surface is often increased, their form modified, and their composition changed. Their period of growth is also shortened and they are enabled to develop at a lower temperature."

DR. J. M. ANDERS, in connection with Dr. G. B. M. Miller, has been continuing his experiments in plant transpiration, and in the *American Naturalist* for September contributes a paper upon the exhalation of ozone by odorous plants. The conclusions reached by his experiments are as follows: 1. Flowering plants, including odorous and inodorous, generate ozone, the former, however, much more actively than the latter. 2. So far as tested, scented foliage does possess the power to produce ozone, and in the case of pine or hemlock foliage in a marked degree. 3. Inasmuch as no reactions occurred on rainy days, it is highly probable that the function demands the influence of the sun's rays, or at least good diffused light.

THE DECEMBER GAZETTE will be a "Laboratory Number," being devoted to accounts of laboratories and laboratory methods. A letter from DeBary's laboratory, brief descriptions of some of our own methods of work, subjects treated, appliances, little conveniences, etc., will be the general features. We would ask every laboratory worker to send us, within a short time, such an account of his own laboratory and methods as he would be glad to receive from other botanists, not forgetting the "little things" which go towards making laboratory work easy. A list of of subjects that have been successfully treated by students is much desired by many of our workers. Such accounts will be edited so as to avoid repetition and at the same time lose nothing.

THE FIRST BULLETIN of the new Société Mycologique was received a short time ago. Of the 130 charter members, only three are from the United States. The bulletin has 132 octavo pages and contains a list of Basidiomycetes of the Vosges, a new classification of the fleshy Discomycetes, a diagram of the excursion made at the first meeting, giving the points at which rare species were found, and closes with two poems addressed to mycophiles, recited at a soirée given the society at the country seat of Prof. Forquignon. The prime object of the society is to encourage a better general acquaintance with the edible and poisonous fungi, and it has made a very auspicious beginning. A branch or section of the society might profitably be established in this country.

MISS ANNA A. STOUT, of New York, has announced her intention to bestow upon Brown University the valuable herbarium of her brother, the late William Stout. The collection is especially rich in ferns, and is accompanied by a fern library of about twenty volumes. Miss Stout has already mounted over 1,800 sheets of ferns alone, and estimates that from 800 to 1000 more will be needed. Probably Dr. Garber's Florida phænogams will require 350 more, and the Atkinson collection of N. Himalayan ferns 560 to 570 sheets. Besides these there are many valuable duplicates of well known collectors. What is now sorely needed is a decent endowment of the botanical professorship. A daily struggle for bread and butter is scarcely compatible with the best research, and Prof. W. W. Bailey deserves more time for his own work.

HYPERICUM GYMNANTHEMUM Engelm. & Gray has been variously considered either a species or variety of *H. mutilum* L. Recently a small clump of plants was found in a bog near Posen (Western Germany), which turn out to be this same form of *Hypericum*. In the *Berichte der Deutschen Botanischen*

Gesellschaft, for February, appears a paper upon the subject by R. v. Uechtritz and P. Ascherson, in which it appears that our plant is widely distributed throughout Eastern Asia, distinct enough from *H. mutilum*, and bearing a much older name, *H. Japonicum* Thunb. So *H. gymnanthemum* Engelm. & Gray must be considered a good species, and become *H. Japonicum* Thunb. But is it a rare survival, its kindred having gone far to the East? Or has it been introduced in recent times? The authors are inclined to think that it has come from America with clover seed.

WE NOTICE elsewhere the new botany of the Science Series which Messrs. Appleton & Co. are now bringing out as claimants for the favor of High School principals and superintendents. That there is a demand for a book on botany adapted to such schools is undoubted, and that the demand has not yet been met is equally true. The abridged and simplified work of Dr. Bessey comes nearer to it than anything that has yet appeared. That work, however, admirable as it is, is ahead of the times, and we must wait and labor to convince school boards and superintendents that a botanical laboratory, equipped with microscopes, is just as essential to a good school as a chemical laboratory. In the second place, Bessey's book requires a teacher that knows *something* about *all* plants, instead of the kind usually employed who know a *very little* about a few plants, the *phanerogams*, and appear to be wholly ignorant that any others exist.

THE MEETING of the American Pomological Society at Grand Rapids, Mich., September 9 to 11, attracted quite a number of prominent botanists. Prof. Bessey, of Nebraska, gave an evening lecture on fungi in their relation to plant diseases, and a number of others presented papers and took part in the discussions. In the course of a short address Commissioner Colman referred to the new work of the Department in the study of plant diseases, under the charge of Prof. Scribner, and added: "I feel that this is a most important field for investigation, and the attention which has been given to the subject by this meeting confirms the wisdom of the course I have pursued in giving this matter special attention." After the address Prof. Beal, of Michigan, offered the following:

Resolved, That this society heartily commends the action of Commissioner Colman, of the U. S. Department of Agriculture, in the appointment of a person to investigate the diseases of plants, and desires to assure him of continued support in his efforts to develop this new line of inquiry.

THE ANT-INHABITED PLANTS form an exceedingly interesting subject in the second volume of Beccari's *Malesia*. Hernandez, about the middle of the seventeenth century, described the stipular thorns of *Acacia cornigera* of Central America, into which certain ants eat, feed upon the pulpy interior, and live in the dwelling thus made. Such inhabited thorns grow larger and distorted, and the ants seem to pay for this hospitality by protecting the tree from other marauding insects. Two woody *Rubiaceæ*, of Sumatra, were described in 1750 by Rumphius as inhabited by ants. They are both epiphytic and attached to the host tree by a large tuberous base, which is cavernous and occupied by ants. The ants by their irritating presence cause the tuberous growth to en-

large, but the enlargement begins during germination, before the ants attack it, an instance of a plant preparing beforehand for expected guests. It is said that seedling plants which fail to become inhabited perish. Dr. Gray, in a review, says that "it is most supposable that this extraordinary formation was acquired gradually; that the normally fleshy caulicle of the ancestral plant, made a nidus by an insect, developed under the disturbing stimulus somewhat as a gall develops, until at length the tendency became hereditary and the singular adaptation of plant to insect was established."

THE SUDDEN DEATH of Hon. George W. Clinton, of Albany, N. Y., was announced in the papers of September 7. He was seventy-eight years old, a son of DeWitt Clinton, and his name is a very familiar one to botanists, especially those of an earlier day. A part of the promised pleasure of the Botanical Club at Buffalo next year was the presence of this venerable and most entertaining botanist, who knew the plant haunts of that locality better than almost any one, and whose company was always delightful. The lateness of the news prevents any fuller and more worthy notice in this issue. The following from the *New York Tribune* gives some of the details of his death:

ALBANY, September 7.—The body of George W. Clinton, vice-chancellor of the Board of Regents, was found in the Rural Cemetery this afternoon, about a quarter of a mile from the lodge. Of late he had manifested a great interest in the study of botany, and when here before it was his custom to follow his favorite study in the cemetery. Last spring he was a frequent visitor. This afternoon at two o'clock he went up for the same purpose, apparently in his usual health. Reaching the lodge, he rested a while and then started up the avenue, in which direction he was found two hours later. Death had apparently been painless and is attributed to heart disease.

CURRENT LITERATURE.

Talks Afield about Plants and the Science of Plants. By L. H. Bailey, Jr. pp. ix, 173. 12mo. Boston: Houghton, Mifflin & Co.

It is a most praiseworthy desire to present the truths of science correctly to the great mass of people who have neither time nor talent to study for themselves. The press to-day in its "scientific columns" has done much to disseminate nonsense, and no science has suffered in this respect more than botany. Hence we are always ready to welcome such a book as the one before us—cheap, attractively written, well adapted to its expected readers, and, better than all, truthful so far as it goes. A professional botanist may discover grave omissions in his special department, but such he ought to find in such a book. We bespeak for Mr. Bailey a large circle of readers, and this attempt to make science attractive to all can not be too highly commended. No criticism is needed regarding the many interesting things omitted, but rather the wonder is how many important things have been compressed into these few pages, and an attractive style preserved, a style that is of necessity somewhat diffuse. The topics presented are such as follow: the flower, the stem, the rose family, the composite family, a peep at the inside, cross-fertilization, hidden flowers, the compass-plant, how some plants get up in the world, carnivorous plants, witch-hazel, a thistle-head, etc.

The Grasses of Maine. Designed for the use of the students of the Maine State College, and the farmers of the state. By C. H. Fernald, A. M. Augusta, 1885. 8mo. pp. 70. 42 plates.

This work, which is privately published and only intended for local use, is a creditable production. One is at once struck with the attractive form in which it is issued, the printer's part being done in a very satisfactory manner. Looking deeper, the author's part is found equally good, and it is only disappointing in its brevity. The value of the grass family as a source of sustenance and revenue is first discussed, successively followed by a description of the general structure of the grass plant, definitions of the terms used in describing grasses, the physical and chemical constitution of grasses, a key to the genera, fifty pages of descriptions and notes on the species, and a suitable index. This occupies about half the volume, the remainder being filled with forty-two full page plates of grasses from Vasey's "Grasses of the United States."

The systematic part gives botanical descriptions in simple language, and notes on the agricultural value of the species. The Latin names are divided into syllables and the accent marked. Authorities following the Latin name are written out in full. Keys to the species of the larger genera and references to the plates assist the novice, who attempts determining the name of a grass, as much as it is possible to do in the absence of a teacher.

Although primarily intended for students, it must be of great service to intelligent farmers throughout the state. The paucity of information, however, regarding the agricultural value of grasses is astonishing. It is almost all derived from Flint, Gould and Vasey. If one examines the works of these writers it is found that they quote from each other, and very largely from Sinclair's standard work "Hortus Gramineus Woburnensis," pretty largely without giving credit. A thorough work on agricultural grasses based on original observations and recent experiments is much needed.

Although Professor Fernald's work contains nothing new, it seems admirably fitted for the practical objects in view, and worthy of special commendation.

Descriptive Botany. A practical guide to the classification of plants, with a popular flora. By Eliza A. Youmans. New York: D. Appleton & Co. 12°, pp. xxvi, 336.

We have before us another attempt to prepare a work on botany suitable for High Schools and Academies. Our judgment as to what is needed by such schools does not at all coincide with that of the author. The study of descriptive botany, while valuable in its place, when pursued *alone* and *as an end* tends to superficiality and gives the student a mere "bowing acquaintance" with plants. The author adheres strictly to the title of her book, and we have in it not a word in regard to the internal structure or functions of plants. Another volume of the series "by an eminent authority" is promised, to treat of physiology. This divorce however will be fatal to the common school work; it will be very rare that any school will give the time necessary to a study of both books.

The method adopted for studying the topic selected is undoubtedly the best, namely, that which requires the student to study the plants and not the book. We think, however, that it will prove impracticable with this book, for this reason: in attempting to cover the whole ground of descriptive (phanerogamic) botany so many terms are introduced that in the time allotted in any ordinary school the pupil can get specimens of only a very few of them, especially of those applied to the flowers. By commencing in the spring and working through the whole summer he might get the majority of illustrations, but no school works so.

In fact the first part of the book is little else than an illustrated glossary. Here is a fair sample:

"The stamens and pistil of flowers have been called *essential* organs, because seeds can not be formed without their presence. As the calyx and corolla cover and nourish [*sic*] these, they have taken the name of *protecting organs*. When the protecting organs are both present in a flower, it is said to be *dichlamydeous*. When there is only a calyx, it is *monochlamydeous*." Page 45.

There is in the book hardly a hint as to homology or the cause of the affinities which are so emphasized on p. 75.

There is the too common quota of errors:

"A *compound raceme* . . . . . When spreading it is called a *panicle*." p. 31.

"RHAPHE.—The connection between the base of the nucleus and the base of the ovule[1]." p. 104.

[1] Previously defined as the point at which the funiculus is attached.—ED.

"Those fruits that consist of achenia on a dry receptacle, as the sunflower, or an enlarged pulpy receptacle, as the strawberry, are aggregate fruits." p. 113.

"The *archegone* or *pistillidia* of mosses also arise in clusters of leaves and are cell-like bodies, having a cap or *epigone* of the same nature as the perigone of antheridia. But the pistillidia bursts its cap, leaving part of it as a sheath below, and is carried upon a stalk . . . at the top of which is seen an urn-shaped body of curious structure, called a *sporange*." p. 180.

"VAGINULE.—The collar or sheath at the base of the seta, resulting from the bursting of the epigone." p. 181.

In the latter part of the book, a "popular flora," the author has undertaken the impossible task of selecting the "common" plants which are "found everywhere" for description and omitting others. It is an impossible task, because it is self-evident that what is "common" in one locality may be extremely rare in another. In glancing through it we noted more than thirty species which every class brings in each spring which were omitted. What is true for this locality is probably true for others.

There is no index to the glossary. Altogether we must conclude that though the publisher's part of the book is excellent, the author's work still leaves the "long-felt want" unsupplied.

Chapters on Plant Life. By Sophie Bledsoe Herrick. Illustrated. Harper & Brothers, New York, 1885. Square 16°, pp. 206.

Popular, accurate and entertaining books on plant habits are few and far between, and it behooves us to welcome every attempt to enlist the interest of young people in the study of plants. Mrs. Herrick has made a successful attempt in this direction—not perfect, to be sure, yet still fairly successful. Her style is vivacious and the book will undoubtedly prove entertaining to those for whom it is written. It is specially commendable in that it does not ignore the existence of the lower cryptogams, some of the most interesting chapters being given to them; in all eight, out of sixteen. The necessity of using the simplest possible terms has been met in some cases by the adoption or invention of admirable ones; in others there is much to criticise. For example, it is misleading to call the oosphere of the mosses and allies an ovule (however etymologically correct it may be) and then use the same word for the ovules of phanerogams. Since the word cell has been frequently used, egg-cell would have been equally simple and entirely accurate. Instances like this are numerous. The whole list of names and terms ought to be carefully revised if another edition is called for. Of course in such a book one does not expect scientific precision, but such liberty does not license inaccuracy, much less error. Errors there are, quite a number of them, big and little and of all degrees of heinousness. It is unfortunate that this should be so, because the book is addressed to those who are not likely to be able to detect them. Some of these errors are among the eighty-four illustrations, most if not all of which have been drawn by the author and photo-engraved. Although marred by these sins of commission, we hope the book will be widely read, not only by "Harper's Young People," but by all boys and girls who are interested in living things. It will certainly do much toward awakening such an interest.